An Atlas of

NEUROSURGICAL

TECHNIQUES

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NEUROSURGEON *The Lahey Clinic*
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*Dedicated to the Fellows in Neurosurgery*

*of the Lahey Clinic*

*Who have contributed much to this book*

*through the stimulus of their industry,*

*knowledge and inquiring minds*

# PREFACE

THE PURPOSE of this Atlas is to picture in detail the methods and steps of surgical maneuver which have evolved from the work of numerous neurosurgeons Precise indications for surgical treatment must be determined by accepted methods of investigation and sound clinical judgment. An atlas cannot depict differential diagnosis, but it can describe techniques, and every effort is made to portray the various neurosurgical procedures accurately

Few modern operative techniques are entirely original most represent a com posite of maneuvers developed over the years This book cannot attempt to cite the work of the many neurosurgeons, some known and some obscure, who have con tributed to the development of modern neurosurgical technique The contributions of neurosurgeons of former generations are found in the standardization of current neurosurgical operations and in the details of procedure that are set forth.

I am grateful to Eric Oldberg for encouraging me to become a neurosurgeon I am deeply indebted to my late friend and teacher Gilbert Horrax, for his moral support and calm understanding during my early experiences in neurosurgery and also to Frank H Lahey who maintained a keen interest in neurosurgical procedures during his lifetime I have incorporated many of his general surgical techniques From Dandy Peet and Adson each of whom I had the good fortune to know well I have learned many safe "short cuts which have been utilized in my daily practice At every opportunity I have attempted to observe the operative procedures performed by other neurosurgeons, concentrating upon any minute detail which might be best suited to my ability and temperament

A competent neurosurgeon must have a thorough knowledge of anatomy and gross pathology He must also recognize his increasing dependence on the anesthesiologist who has specialized knowledge for handling neurosurgical cases. Since clinical and pathologic conditions vary some flexibility in the selection and execution of a surgical procedure will always be necessary A basic technique must be mastered

however so that the operation may be performed in a chronologic order which permits maximum utilization of the assistants and instrument nurse The development of a tidy technique demands a precise and orderly concept of the sequence of the operation and a disposition to follow the same technique unless the need for deviation becomes obvious Unfortunately frequent innovations in technique are most appealing to the least experienced surgeon

The satisfaction derived from bringing a neurosurgical procedure to its conclusion will be proportional to the surgeon s competence, skill and mastery of an accepted technique If this Atlas contributes to this attainment these efforts will not be in vain

I want to express my appreciation to Miss Eleanor Samsel our head neurosurgical nurse, whose cooperation and essential help made this book possible. I also want to thank Dr Lawrence S Van Blaricom for his assistance Acknowledgment for the drawings accompanies the plates. I wish to acknowledge further the work of the following artists—P D Malone, Robert Ullrich Melford D Diedrick, and Francis E. Steckel—and also the help of our Editorial Department. My thanks go to the staff of the W B Saunders Company for their help and encouragement

JAMES L. POPPEN

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Part VI NEUROSURGICAL DIAGNOSIS

# Part I HEAD

## *Section 1* EXTRACRANIAL PROCEDURES

SCALP



ORBIT

# REMOVAL OF SEBACEOUS CYST (WEN) OF THE SCALP

**A** A small area of the scalp is shaved.

In this particular instance the entire scalp has been shaved. Unless there are many wens of the scalp however it is necessary to shave only a small area immediately in the vicinity of the wen

**B** The scalp is incised to the capsule.

**C** Dissection of the capsule with scissors is begun.

**D** Completion of dissection of the capsule.

**E** Pressure is exerted with the thumb of each hand immediately next to the wen to deliver it intact

**F** The scalp is closed with interrupted black silk sutures.



Plate 1

# REMOVAL OF SEBACEOUS CYST (WEN) OF THE SCALP

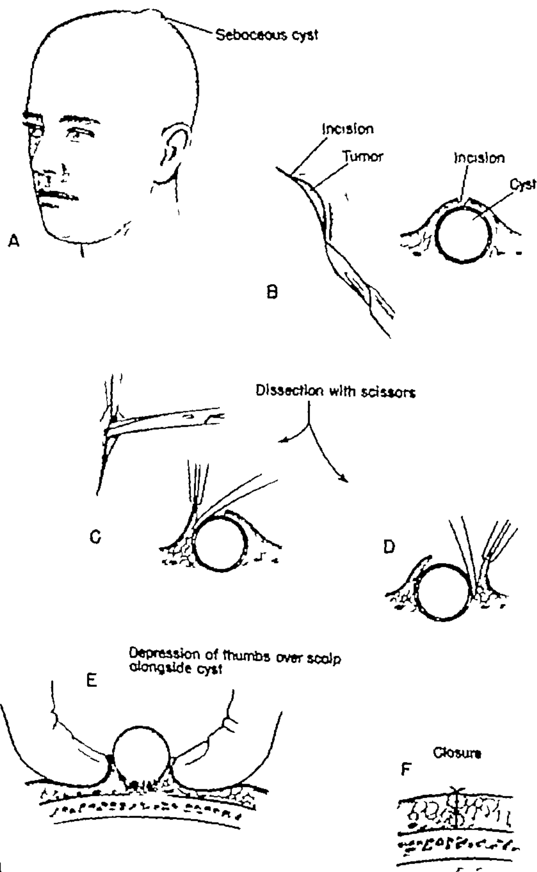



Plate 1

# SCALP LACERATIONS PLASTIC PROCEDURES

**A** Ragged laceration of scalp

**B** Wide excision of traumatized scalp edges.

**C** Undermining of scalp with periosteal elevator to allow mobilization of scalp for closure.

Bone is inspected visually and by palpation for possible fracture.

**D** Closure.

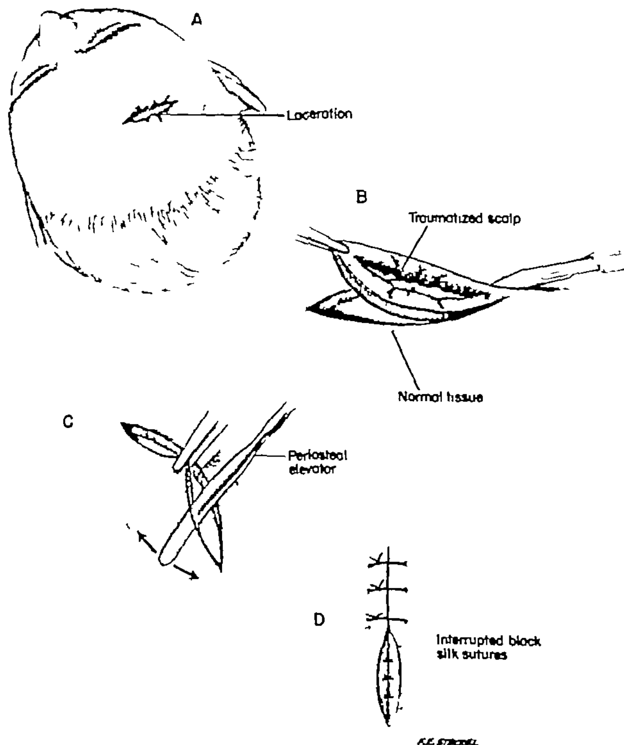

A
Laceration
B
Traumatized scalp
Normal tissue
C
Periosteal elevator
D
Interrupted black silk sutures

Plate 2

# CIRSOID ANEURYSM OF SCALP

A Location of cirsoid aneurysm The type of scalp incision shown is made at a sufficient distance from the network of blood vessels.

B Scalp flap turned down with periosteum and galea attached. Larger vessels at the base of the scalp flap are individually ligated well away from the malformation

*(Continued on Plate 4)*

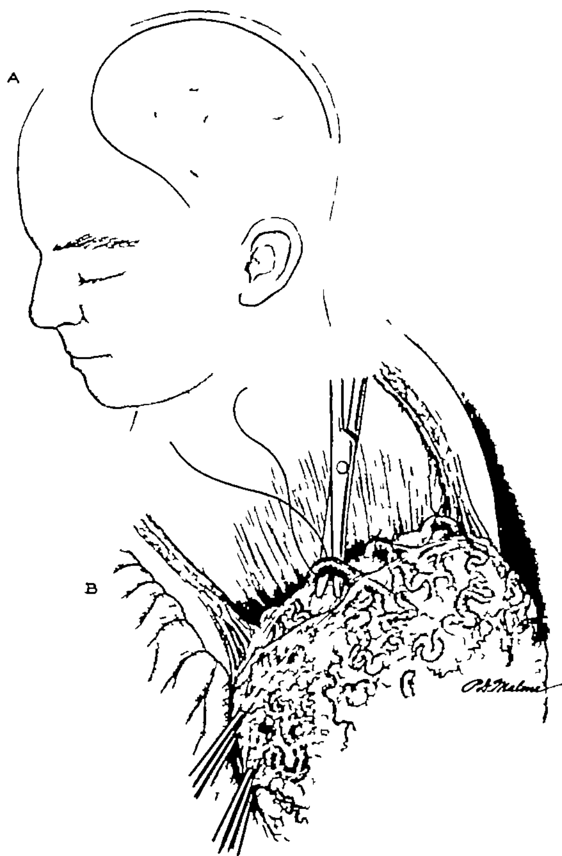



Plate 3

**C** The galea is incised over the individual thin-walled, greatly enlarged veins.

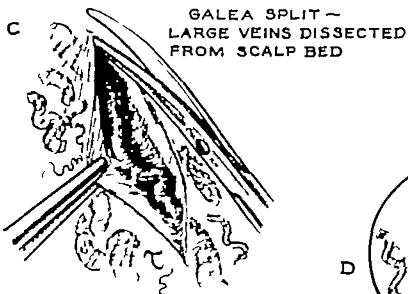
**D** The veins are opened.

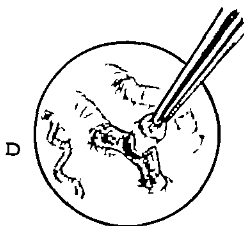
**E** Hemostat is inserted into the lumen of the veins and opened

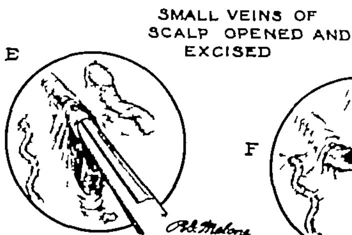
**F** The vein walls are completely removed

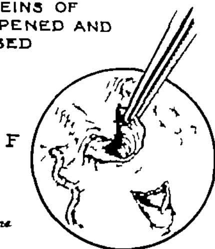
If vein walls in the smaller vessels are not removed recanalization takes place at a later date. Firm pressure bandages should not be applied because of the avascularity of the remaining scalp flap.

# CIRSOID ANEURYSM OF SCALP



**C** The galea is incised over the individual thin walled greatly enlarged veins.

**D** The veins are opened

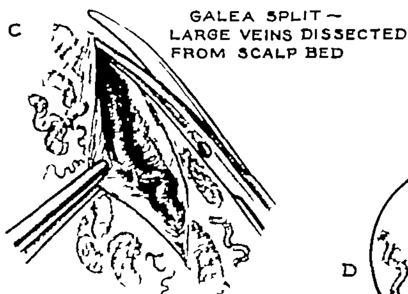
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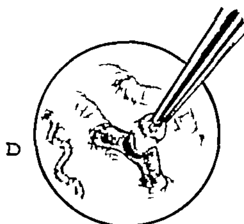
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If vein walls in the smaller vessels are not removed recanalization takes place at a later date. Firm pressure bandages should not be applied because of the avascularity of the remaining scalp flap

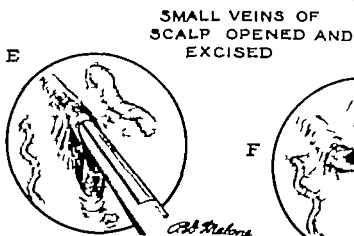


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SMALL VEINS OF
SCALP OPENED AND
EXCISED



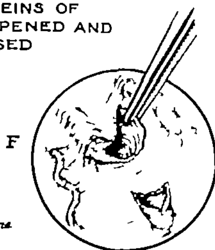




Plate 4

# TRIGEMINAL NEURALGIA ALCOHOL INJECTION OF THE FIRST DIVISION AT THE SUPRAORBITAL AND INFRAORBITAL NERVES

1 Alcohol injection of the supraorbital nerve

A The thumb is used to palpate the supraorbital notch A fine 26 caliber needle is inserted into the notch usually the nerve can be palpated with the tip of the needle As soon as the patient complains of radiating pain in the supraorbital division, a few drops of 80 per cent alcohol and 1 per cent procaine are injected.

B Supraorbital and supratrochlear nerves.

C Type of needle with short bevel used

2 Alcohol injection of the infraorbital nerve

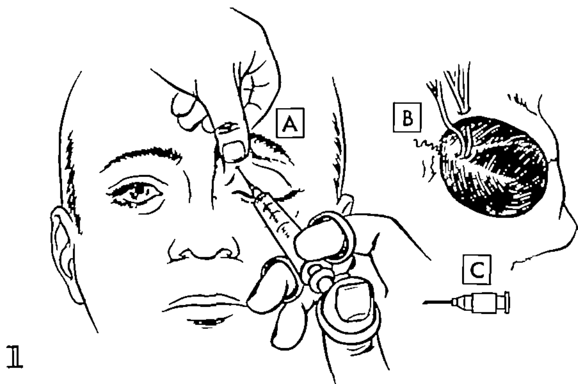
A The index finger of the left hand is placed over the inferior rim of the orbit the needle is inserted into the nasolabial fold

B By gentle probing with the point of the needle the infraorbital canal is entered and 0 5 to 1 0 cc of alcohol injected

> There should be immediate complete anesthesia of the infraorbital distribution. The ala of the nose and the medial portion of the upper lip should be tested for anesthesia If they are completely anesthetized the injection will be successful

In infraorbital alcohol injections, the bone over the maxillary sinus is occasionally found to be membranous in type and easily entered Before alcohol is injected therefore, suction is exerted on the plunger to determine whether air enters the syringe. If so the needle should be replaced in the proper position The needle should not be inserted too deeply into the infraorbital canal, since the point may enter the inferior portion of the orbit because of a thin membranous plate

TRIGEMINAL NEURALGIA ALCOHOL INJECTION OF THE FIRST DIVISION AT THE SUPRAORBITAL AND INFRAORBITAL NERVES



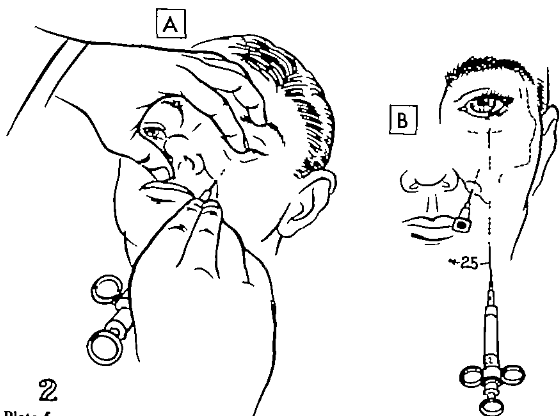




Plate 5

# TRIGEMINAL NEURALGIA ALCOHOL INJECTION OF THE FIRST DIVISION AT THE SUPRAORBITAL AND INFRAORBITAL NERVES

1 Alcohol injection of the supraorbital nerve.

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- **B** *Supraorbital and supratrochlear nerves*

- **C** Type of needle with short bevel used.

2 Alcohol injection of the infraorbital nerve.

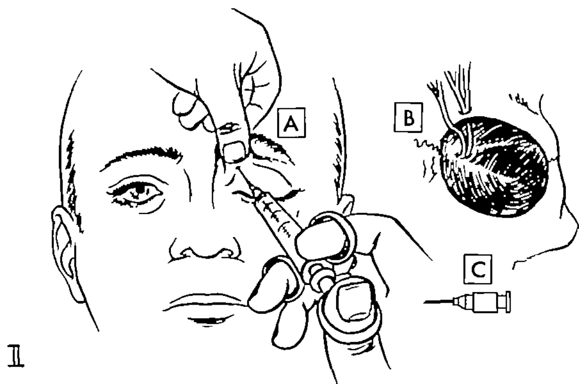
- **A** The index finger of the left hand is placed over the inferior rim of the orbit the needle is inserted into the nasolabial fold

- **B** By gentle probing with the point of the needle, the infraorbital canal is entered and 0 5 to 1 0 cc. of alcohol injected.

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TRIGEMINAL NEURALGIA ALCOHOL INJECTION OF THE FIRST DIVISION AT THE SUPRAORBITAL AND INFRAORBITAL NERVES



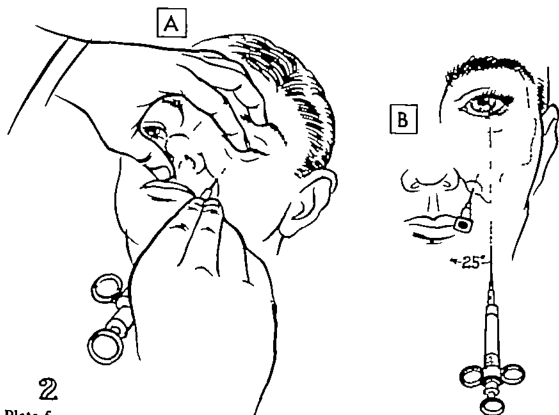




Plate 5

# TRIGEMINAL NEURALGIA ALCOHOL INJECTION OF THE SECOND DIVISION OF THE FIFTH CRANIAL NERVE AT THE FORAMEN ROTUNDUM

Alcohol injection of the second division of the trigeminal nerve is used only if the pain involves the roof of the mouth. Otherwise, infraorbital nerve injection is adequate, and *is a simple procedure* compared to the injection at the foramen rotundum.

**A** The position of the patient's head and the position of the surgeon are identical with those used in the third division alcohol injection The needle is marked at 6 0 cm. with a tiny *piece of adhesive, and is directed slightly more anteriorly than in the third division in order* to strike the external pterygoid plate.

**B** *a-1* Needle in contact with the external pterygoid plate.

*a-2* Needle directed slightly more anteriorly and toward the base of the skull, *entering the* pterygomaxillary fissure.

The nerve is usually reached at a depth of 5.5 cm., causing characteristic radiation of pain into the ala of the nose, upper lip and roof of the mouth. Two or three drops of *80 per cent alcohol and 1 per cent procaine are injected causing severe exacerbation of* discomfort in these regions. Complete, immediate anesthesia follows. An additional 0 5 cc. of solution is then injected

*b* The anterior approach to the second division is sometimes preferable, especially if there is an overhanging maxilla or if the pterygomaxillary fissure cannot be entered through the zygomatic notch. The needle passes medially at a 40 degree angle, anterior to the coronoid process and immediately posterior to the maxillary process

As the needle enters the pterygomaxillary fissure (a narrow opening about 0 5 cm. wide, as demonstrated) it usually strikes either the external pterygoid plate behind or the posterior border of the maxilla in front. As a rule, the nerve is reached at a depth of 5 5 cm. depending on the width of the skull. It is important not to go deeper than 6 0 cm. at any time, because of possible injury to important structures, especially the optic nerve.

If the external pterygoid plate is struck initially it can be used as a valuable landmark. The foramen rotundum lies anteriorly and approximately 0 5 cm. deeper If the posterior portion of the maxilla is reached before the pterygomaxillary fissure is entered, it will also serve as a guide the fissure in which the nerve lies is bounded by the maxilla anteriorly and the external pterygoid plate posteriorly

The nerve will be reached by gentle manipulation of the needle, unless unusually bony prominences make it impossible. As soon as the needle enters the nerve tissue, a spray of pain will be felt along the course of the nerve. Here again only a few drops of alcohol are injected at a time. If complete immediate anesthesia of the upper lip ala of the nose and roof of the mouth takes place with two or three drops of alcohol, another 0 5 cc. is injected slowly

# TRIGEMINAL NEURALGIA ALCOHOL INJECTION OF THE SECOND DIVISION OF THE FIFTH CRANIAL NERVE AT THE FORAMEN ROTUNDUM

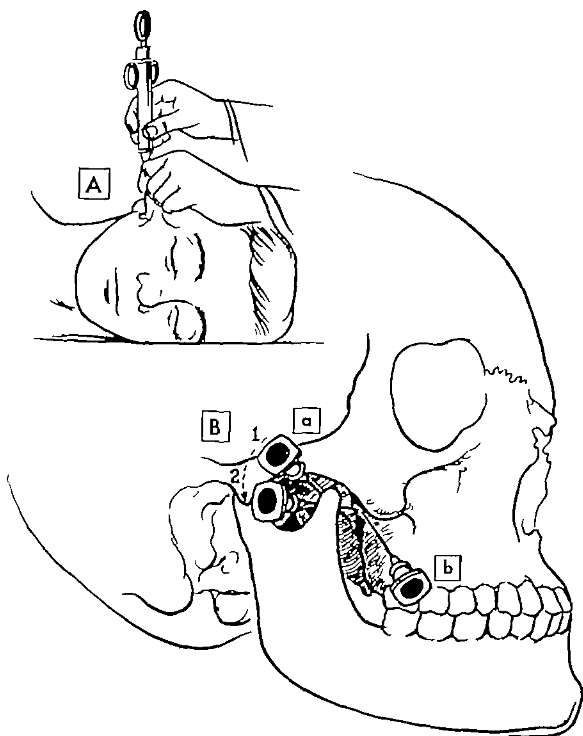



Plate 6

# TRIGEMINAL NEURALGIA ALCOHOL INJECTION OF THE THIRD DIVISION AT THE FORAMEN OVALE

**A** Position of patient's head and surgeon the patient's head is turned toward the left and the operator stands at the head of the table. A small area of skin immediately beneath the zygoma is sterilized The inferior portion of the zygomatic notch is palpated firmly so that a small impression of the finger remains on the skin The needle is first marked at 5.5 cm. with a tiny piece of wax or adhesive, then inserted.

The needle is directed slightly upward and backward to a depth of 4 5 cm. (the usual depth, which varies with the width of the skull) Immediate reaction is noted with the patient under light anesthesia, depending on the depth of anesthesia. The corner of the mouth is usually drawn up as the nerve is reached. If the nerve is not reached at the usual depth the needle is slightly withdrawn.

**B** *1* The needle is redirected slightly forward to contact the external pterygoid plate. This is an essential landmark because the foramen ovale lies just posterior and slightly medial to it.

*2* When the pterygoid plate is located the needle is again slightly withdrawn and directed backward at a minimal degree until the nerve is entered, as evidenced by pain radiation.

It may be necessary to repeat this process several times, and the variation in depth of the foramen must also be considered. In some patients the foramen may be reached at a depth just under 4 5 cm —and, rarely even at a depth as great as 5 0 cm.—from the skin When the nerve trunk has been entered and a few drops of alcohol injected, the plunger of the syringe is withdrawn to insure that the point of the needle is not in an artery The patient's lower lip near the median line is tested for anesthesia. If the nerve has been struck properly the sensory loss is immediate in this portion of the lip the lower gum, and half of the anterior two-thirds of the tongue.

When the level of anesthesia has been determined, another 0.5 to 1 0 cc. of alcohol is slowly injected. The needle is then withdrawn and pressure is applied with sterile gauze over the point of entrance, to prevent oozing from the skin. The patient is now asked to open his mouth. If the injection of the third division has been complete, the lower jaw will deviate distinctly toward the affected side, denoting that the motor root has been affected as well.

At times when the needle is in the proper position and depth there is no extension of pain down the jaw but a severe pain is present at the tip of the needle. Frequently there is radiation to the external portion of the ear anteriorly but the operator should be certain that the patient does not complain of pain deep in his ear canal.

TRIGEMINAL NEURALGIA ALCOHOL INJECTION OF THE THIRD DIVISION AT THE FORAMEN OVALE

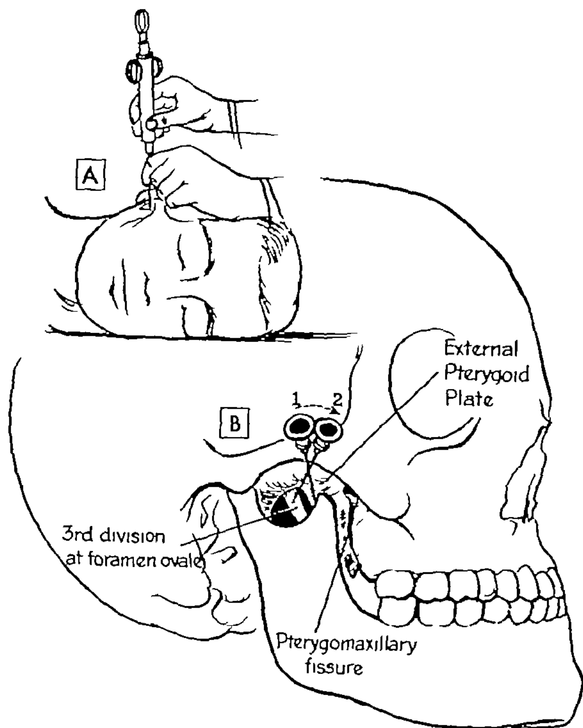



Plate 7

# TRIGEMINAL NEURALGIA SUPRAORBITAL NEURECTOMY

**A** Position.

**B** Semicurved incision through shaved eyebrow

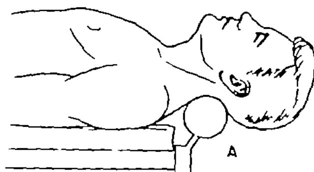
**C** Relation of the supraorbital branches and the infratrochlear branch to the line of incision.

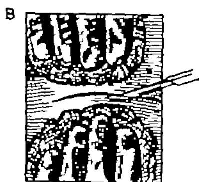
**D** The main trunk of the supraorbital nerve extends through the bony foramen.

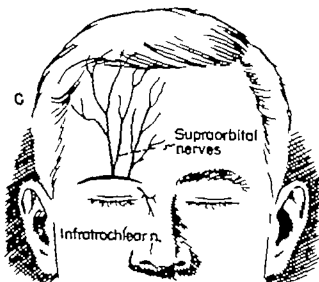
**E** The thin, bony ledge of the orbital rim is removed with small rongeurs.

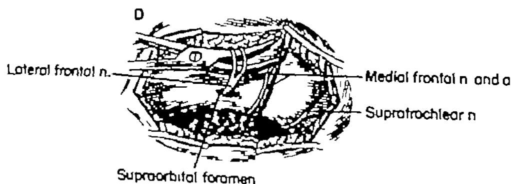
**F** Avulsion of distal branches.

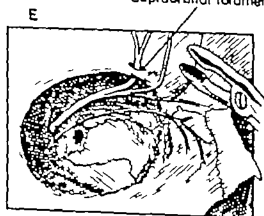
*(Continued on Plate 9)*


A


B


C
Supraorbital nerves
Infratrochlear n.


D
Lateral frontal n.
Medial frontal n and a
Supratrochlear n
Supraorbital foramen


E

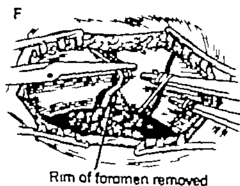

F
Rim of foramen removed

Plate 8

G Orbital fat is separated from the orbital roof by thin cotton pledgets.

H The nerve is dissected and avulsed intraorbitally

I Closure.

J Bandage.

K Rubber bag partially inflated with air placed over orbit.

L Light pressure bandage applied over rubber bag to prevent swelling and extravasation of blood.

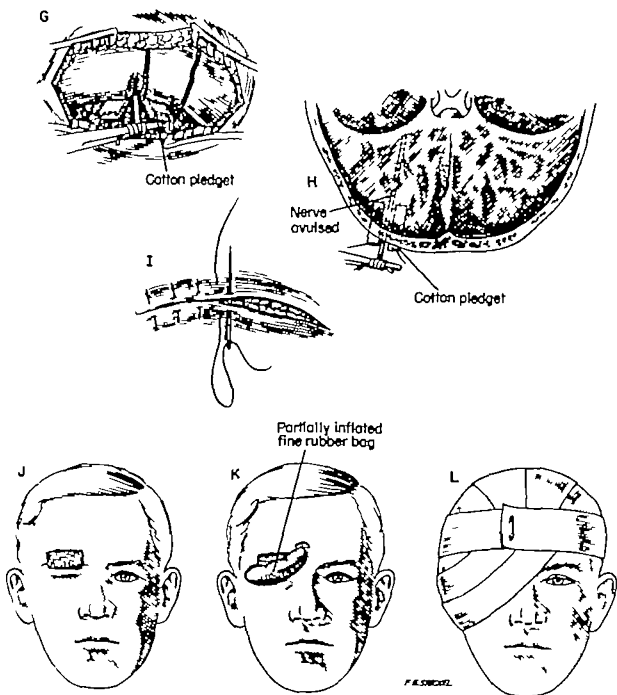

G
Cotton pledget
H
Nerve avulsed
Cotton pledget
I
Partially inflated fine rubber bag
J
K
L

Plate 9

**A** Infraorbital nerve distribution

**B** Position with head well extended.

**C** Incision is made just above the gingival mucous membrane

**D** The mucous membrane and periosteum are elevated from the maxillary bone to the infra orbital foramen

**E** The nerve is separated and traction maintained with nerve hook.

*(Continued on Plate 11)*

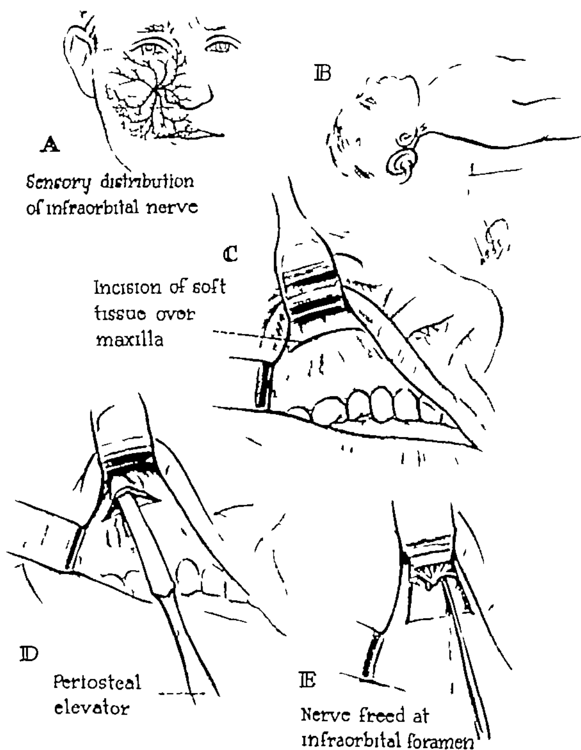

A
Sensory distribution
of infraorbital nerve
B
C
Incision of soft
tissue over
maxilla
D
Periosteal
elevator
E
Nerve freed at
infraorbital foramen

Plate 10

**F** Nerve branches can be separated from the soft tissues for a considerable distance with a periosteal elevator  the nerve is avulsed from the infraorbital foramen.

**G** A small metal probe is inserted into the infraorbital foramen and coagulation applied. The distal portion of the smaller branches is avulsed.

**H** Closure is made with fine catgut which can be left *in situ*.

**I** A loosely inflated bag is inserted over the maxilla.

**J** A light pressure bandage is applied for a period of twelve to twenty-four hours.

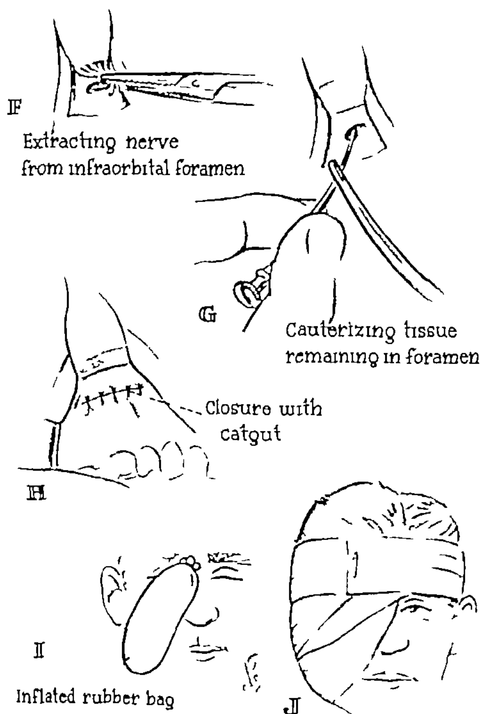

F
Extracting nerve
from infraorbital foramen
G
Cauterizing tissue
remaining in foramen
Closure with
catgut
H
I
Inflated rubber bag
J

Plate 11

A A semicurved incision is made at the inferior margin of the angle of the jaw

B The skin is reflected upward and the masseter muscle exposed

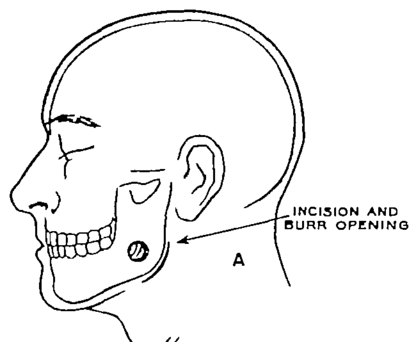
C The masseter muscle has been split and seperated with small vein retractors and a burr opening made through the central portion of the mandible, exposing the inferior dental nerve.

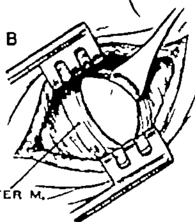
D The nerve is divided and avulsed as far as possible.

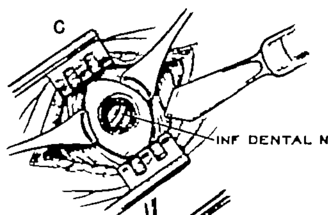
The ends of the nerves usually break off at the edge of the bone that is exposed.

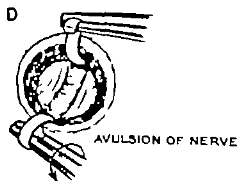
E A nerve hook is inserted into the foramen cephalad and distally coagulation is applied.

The skin is closed with two layers of interrupted black silk sutures.


INCISION AND
BURR OPENING
A


B
MASSETER M.


C
INF DENTAL N


D
AVULSION OF NERVE

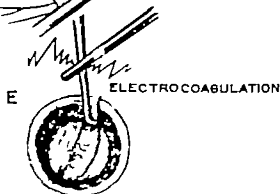

ELECTROCOAGULATION
E

Plate 12

Severe postherpetic neuralgia of the first division of the fifth cranial nerve is not amenable to surgery if the skin is completely anesthetic in the area involved. If the skin is intensely hyperanesthetic, however with associated severe burning sensation and lightning pain, an elliptical excision of a portion of the involved skin can be made.

**A** Excision.

**B** Supraorbital nerve avulsed as in the operative technique for Supraorbital Neurectomy (Plates 8 and 9)

**C** Scalp undercut in the extensive area involved by scar tissue.

**D** Closure with two layers of interrupted black silk.

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Drawing reproduced from Van Blaricom, L.S., and Horrax, G Chronic postherpetic neuralgia, J.A.M.A., *161* 511-516, June 9 1956, by permission of the American Medical Association.

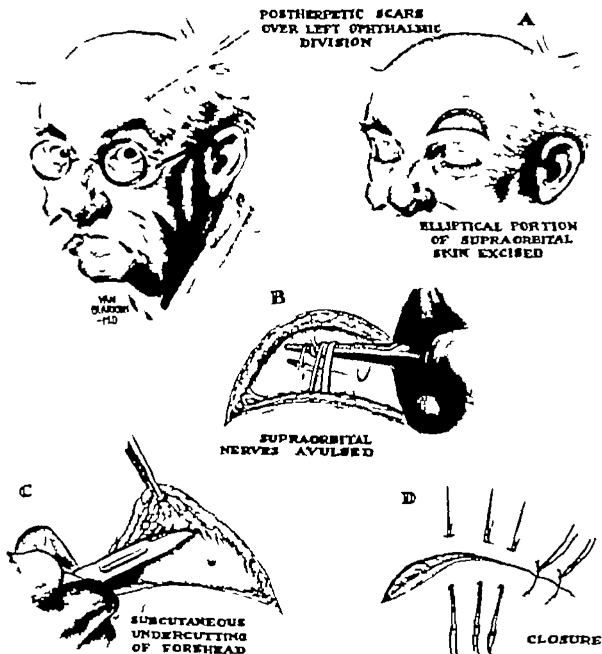

POSTHERPETIC SCARS
OVER LEFT OPHTHALMIC
DIVISION
A
ELLIPTICAL PORTION
OF SUPRAORBITAL
SKIN EXCISED
B
SUPRAORBITAL
NERVES AVULSED
C
SUBCUTANEOUS
UNDERCUTTING
OF FOREHEAD
D
CLOSURE

Plate 13

Using a temporal approach the sensory root of the fifth cranial nerve is subjected to compression, differential section or complete section

The *scalp is prepared immediately preceding the introduction of anesthesia. The patient is* questioned about the site of the pain regardless of the number of times the site is reported on the record

Intratracheal anesthesia is instituted. The lower extremities are wrapped with Ace bandages and the patient is placed in a sitting position

**A** Outline of the site of incision.

**B** Index finger is placed immediately beneath the zygomatic process incision is outlined. The incision is brought down to the tip of the index finger so that it extends over the zygomatic *process but not beneath it.*

**C** Scalp and temporal muscle fibers are separated with a self retaining retractor exposing the junction of the squamous portion of the temporal bone and the zygomatic process. One burr opening is made immediately above the zygomatic process and another 1 or 2 cm. above this process

In the majority of patients there is a bony ledge or enostosis, as indicated in the inset. This allows removal without damage to the dura

**D** A rectangular portion of bone is removed

In most instances the lower portion of the opening should be wider anteriorly than is the superior portion. This prevents unsightly depression in the temporal region at a later date and, furthermore, tends to make the approach easier

The dura is separated from the lower edge of the squamous portion of the temporal bone *with a right angle periosteal elevator*

*Inset* A cotton pledget is then inserted between the separated dura and the bony edge the inferior ledge is removed with a Kerrison punch.

(*Continued on Plates 15 and 16*)

TRIGEMINAL NEURALGIA SENSORY ROOT OPERATIONS (INTRACRANIAL)

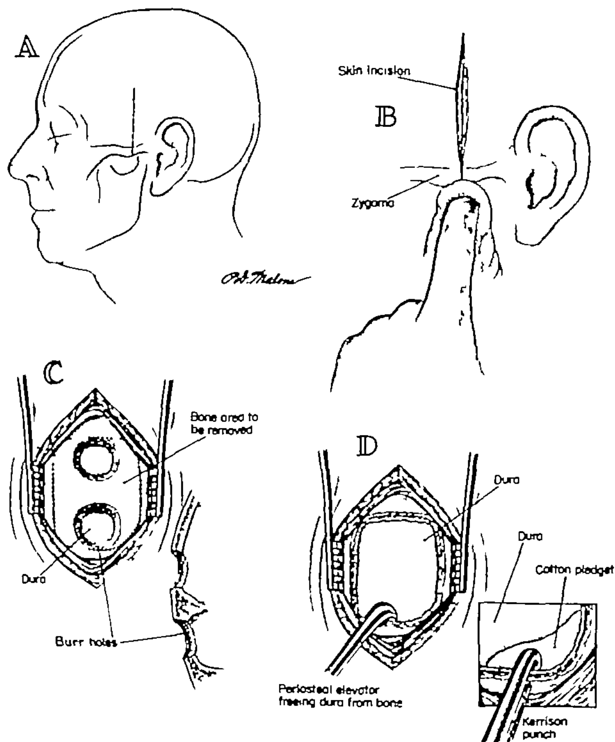



Plate 14

**E** The dura is gently elevated with a malleable blade retractor The dura is separated from the floor of the temporal fossa anteriorly toward the foramen rotundum, with a rolled cotton pledget or if firmly adherent, with a periosteal elevator

Annoying venous oozing from the dural attachments between the second and third divisions may occur If this happens, a large, soft piece of bone wax is inserted into the cavity and gently compressed medially against the oozing portion. If a large enough piece has been inserted all oozing will stop. The wax can be readily molded and the operation completed without unnecessary bleeding. It is important that the sensory root is not divided until the visualization is adequate and clear All bone wax should be *removed before closure is made.*

At times bony projections or spicules arise from the floor of the skull these can be readily removed with a fine chisel and mallet.

After the maxillary division has been identified at the foramen rotundum, the dura is separated posteriorly toward the foramen ovale. The middle meningeal artery will become visible. The foramen spinosum is plugged with a wisp of cotton and covered with a small piece of wax the artery is divided, as in the *inset* The distal end of the cut artery is occluded with the electrosurgical unit.

**F** After the middle meningeal artery has been divided, the line of cleavage between the temporal dura and the dura propria is developed by blunt dissection with a firmly rolled cotton pledget. With firm pressure kept constantly over the anterior rim of the foramen ovale, this dissection is made by a rubbing movement continued medially and posteriorly for a distance of 3 or 4 mm., uncovering the anterior portion of the third division. This causes an angle to develop in the dura immediately lateral to the third division By a shallow incision with a scalpel exactly at that level the temporal dura is split over the petrosal fibers. The outer layer of the dura remains intact over the petrosal nerves, thus preventing injury to them

The temporal dura is then separated from the dura propria lying over the ganglion of the posterior root by similar sweeping motions—that is, by down and up movements. The temporal dura is reflected from the dura propria over the sensory root approximately to the apex of the temporal bone. This level can be readily detected by the fine transverse fibers which will appear in the dura propria over the sensory root.

**G** Approximate relationship of foramen spinosum to third division and petrosal nerves.

**H** A lighted retractor is used. A semicurved incision is made through the dura propria and arachnoid and elevated with the end of the retractor exposing the sensory root.

If the patient and surgeon have decided that a compression procedure should be performed, the sensory root is lightly massaged with a cotton pledget or staphylorrhaphy at this time. If the differential section is to be instituted, the central portion of the sensory root fibers can be readily separated to identify the motor root.

**I** The inferior portion of sensory root is elevated and retracted laterally exposing motor root.

If the second and third divisions of the fifth cranial nerve are involved, a sharp-pointed knife is used to divide the sensory root as it is elevated with the nerve hook.

Great care must be taken in dividing all the fibers in the lateral gutter since a few of the fibers may escape section if the necessary care is not taken at that point.

A few sensory fibers may be closely associated with the motor root and be left intact if thorough inspection is not made. In most instances the motor root is divided into two or three small branches which can be readily separated from each other Care should be taken, however that they are not mistaken for sensory fibers

**J** Motor root and ophthalmic sensory fibers are intact and the sensory fibers corresponding to the second and third divisions are divided.

(*Continued on Plate 16*)

# TRIGEMINAL NEURALGIA SENSORY ROOT OPERATIONS (INTRACRANIAL)

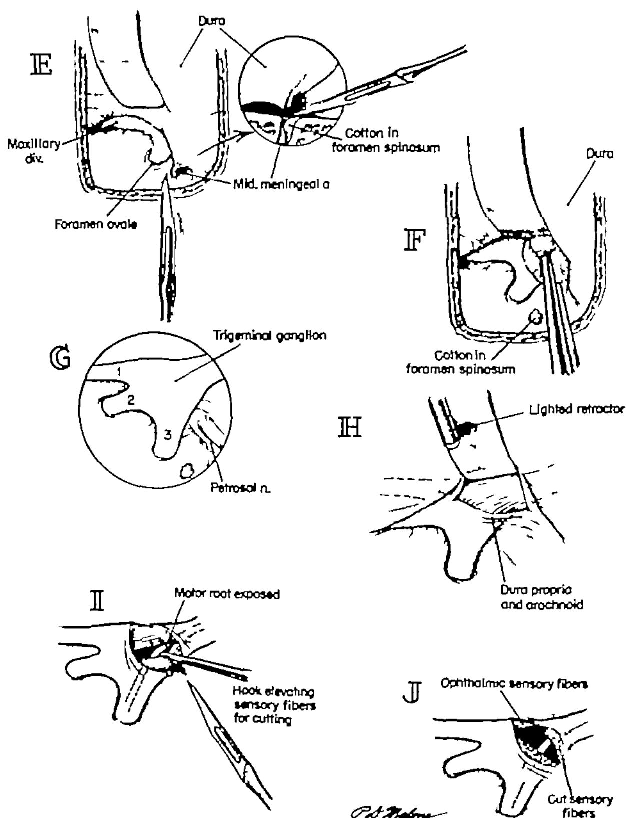



Plate 15

A small piece of Gelfoam, covering the sensory root, is inserted immediately over the incision made in the dura propria and arachnoid All bleeding points from the dura are stopped. Normal saline may be injected into the subdural space so that the cavity is completely obliterated.

K The temporal muscle is closed with several layers of interrupted black silk. The temporal fascia should also be closed carefully to prevent later unsightly depression of the tissues A small dressing is applied.

L A Buller's shield is attached to the eye in all cases, regardless of whether compression or sensory root avulsion has been performed The shield is removed as soon as the corneal reflex is intact.



Plate 16

# TRIGEMINAL NEURALGIA SENSORY ROOT OPERATIONS (INTRACRANIAL)




Plate 16

# OCCIPITAL NEURALGIA NEURECTOMY

Two methods of occipital neurectomy may be used to advantage.

**A** Incision is made lateral to and just above occipital protuberance Scalp is incised to fascia containing bundle of occipital nerves and arteries.

**B** The greater occipital nerve branches and vessels are exposed

**C** Blunt scissors are used to separate nerves from fascia and muscle

**D** Avulsion of distal ends of greater occipital nerves.

**E** Avulsion of proximal ends of nerves.

Arteries are usually occluded with the electrosurgical unit and divided, with the hope that component vascular discomfort may be ameliorated.

*(Continued on Plate 18)*

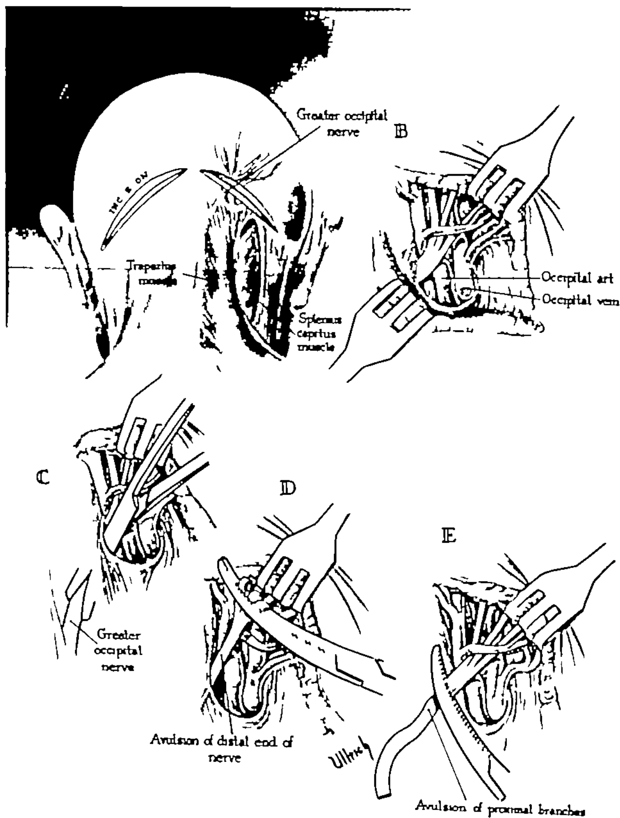

A
INCISION
Greater occipital nerve
B
Trapezius muscle
Occipital art
Occipital vein
Splenius capitus muscle
C
D
E
Greater occipital nerve
Avulsion of distal end of nerve
Avulsion of proximal branches

Plate 17

The alternate method of occipital neurectomy through a midline incision is outlined here With this procedure it is possible to remove the upper cervical branches as they emerge along the cervical canal. It is more difficult, however to resect the auricular branch, as may be necessary at times. In that instance the procedure demonstrated in Plate 17 is preferable, since the auricular branches can be readily exposed and divided

The lettered steps of this procedure are self-explanatory

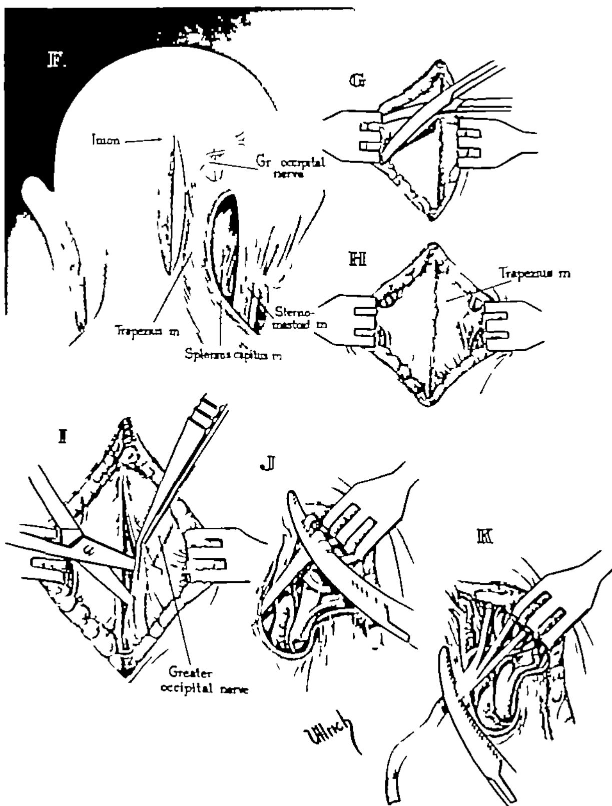

F.
Inion
Gr occipital nerve
Trapezius m
Splenius capitis m
Sterno-mastoid m
G
H
Trapezius m
I
Greater occipital nerve
J
K
Ullrich

Plate 18

**A** Incision is made over the course of the superficial temporal artery through the superficial tissues.

**B** The soft tissues are separated superficially with the dissecting Metzenbaum scissors.

**C** The bundle of arteries, veins and fine temporocutaneous branches of the fifth cranial nerve is separated from the temporal muscle fascia.

**D** The bundle raised *en bloc* with a large nerve hook the segment is resected between ligatures.

**E** The resected mass of arteries veins and nerves.

Closure of the skin is made with interrupted end-on mattress sutures.

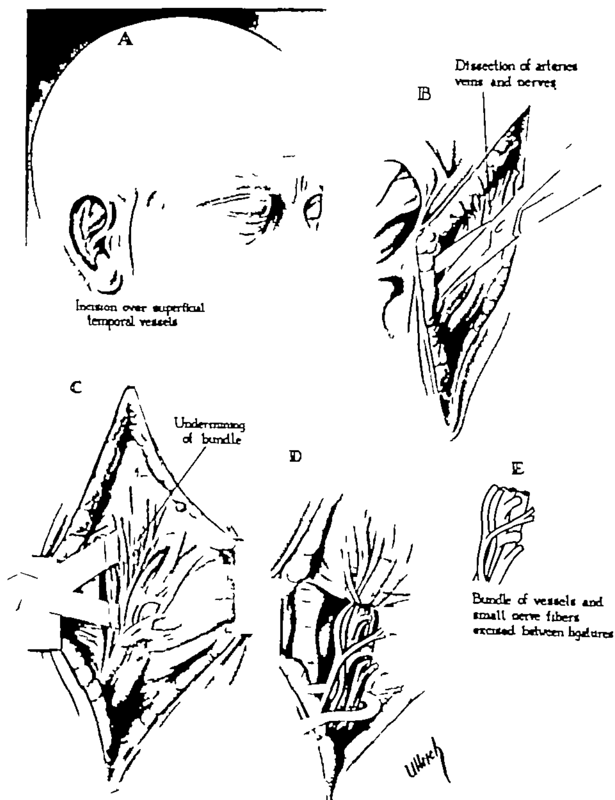

A
Incision over superficial temporal vessels
B
Dissection of arteries veins and nerves
C
Undermining of bundle
D
E
Bundle of vessels and small nerve fibers excised between ligatures
Ullrich

Plate 19

## BLEPHAROSPASM AND SPASMODIC FACIAL TIC DIFFERENTIAL SECTION OF FACIAL NERVE

**A** Line of incision.

**B** Small facial branches exposed distal to the parotid gland By stimulation with faradic current the various muscle innervations can be readily determined, even though the patient is under anesthesia

Thus, if the patient has severe facial spasm of the orbicularis oculi inferioris and superioris previous to surgery (blepharospasm) these fibers can be readily determined by stimulation as long as the entire half of the face is exposed during surgery

Branches which, when stimulated, simulate the contractions complained of by the patient are divided. In most instances it is preferable to omit sectioning of the branches that innervate the frontalis muscles.

**C** Branches divided so that stimulation of the facial nerve causes only mild contraction of the previously involved muscles.

*(Continued on Plate 21)*

# BLEPHAROSPASM AND *SPASMODIC* FACIAL TIC DIFFERENTIAL SECTION OF FACIAL NERVE

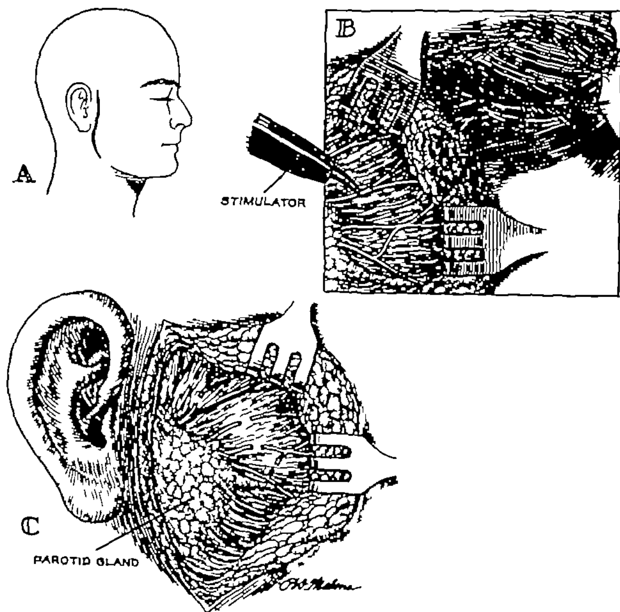



Plate 20

**D** Arborization of facial nerves allowing impulses to reach affected muscles through fine fibers.

BLEPHAROSPASM AND SPASMODIC FACIAL TIC DIFFERENTIAL SECTION OF FACIAL NERVE

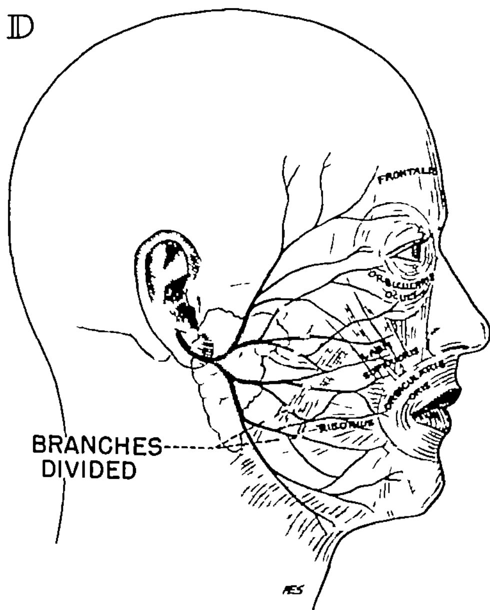



Plate 21

# OSTEOMA OF FRONTAL SINUS

A Anteroposterior x ray film demonstrating osteoma and frontal sinus.

B Lateral x ray film showing the same.

(*Continued on Plate 23*)




Plate 22

# OSTEOMA OF FRONTAL SINUS

Osteoma in the frontal sinus should be removed only if it has caused local disturbance, such as downward outward displacement of eyeball or intracranial extension

(; Modified coronal incision osteoplastic bone flap

1) Frontal sinus open demonstrating distortion of the orbital plate.

I; Roof of the sinus removed and osteoma enucleated.

I Floor of the sinus removed exposing the orbital tissues.

The open portion of the sinus can be readily repaired with Gelfoam and a small stamp of muscle. The bone flap is replaced and the usual closure made.

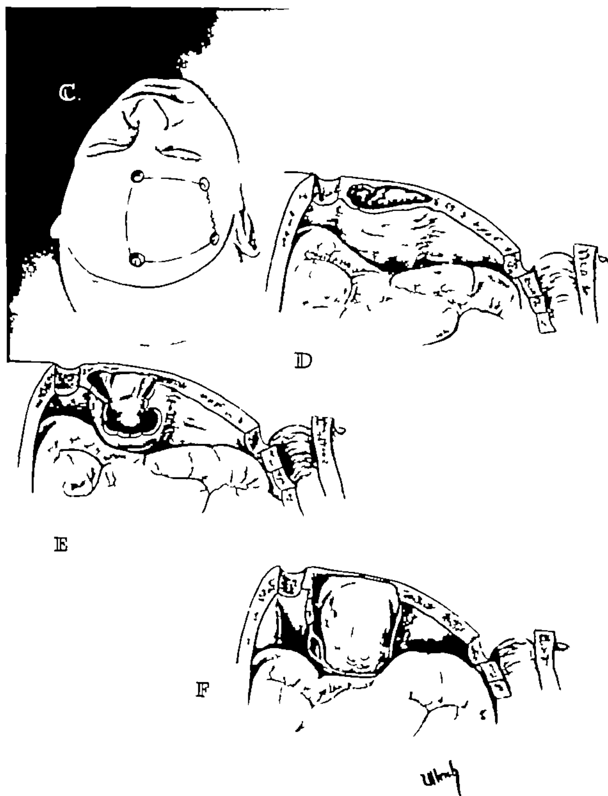



Plate 23

Osteoma in the frontal sinus should be removed only if it has caused local disturbance, such as downward, outward displacement of eyeball or intracranial extension.

C Modified coronal incision osteoplastic bone flap

D Frontal sinus open demonstrating distortion of the orbital plate.

E Roof of the sinus removed and osteoma enucleated.

F Floor of the sinus removed exposing the orbital tissues.

The open portion of the sinus can be readily repaired with Gelfoam and a small stamp of muscle. The bone flap is replaced and the usual closure made.

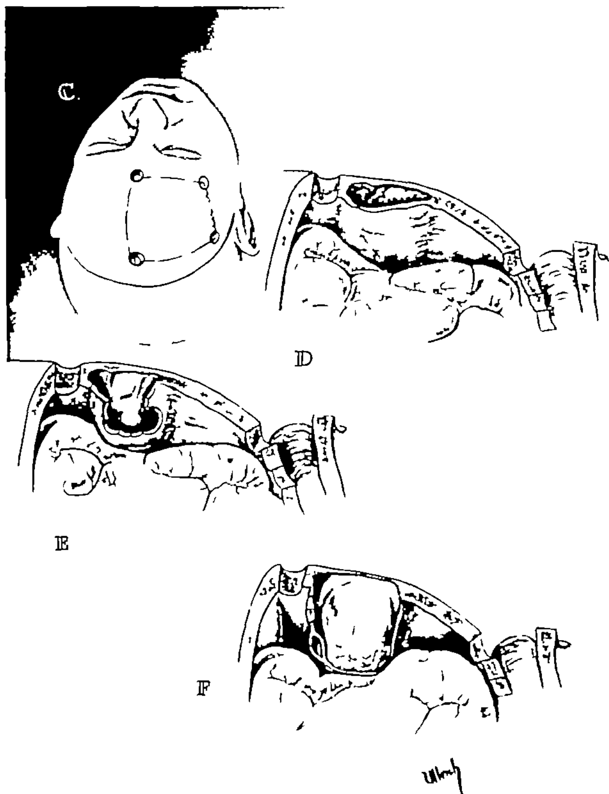



Plate 23

# INTRAORBITAL TUMORS

Intraorbital tumors can be readily exposed transcranially The surgical approach is similar to the anterior approach to pituitary adenomas, with the exception that the dura is separated from the orbital plate as in orbital decompression for malignant exophthalmos. (Refer to Chromophobe and Chromophil Pituitary Adenomas, Plate 55 and Malignant Exophthalmos Bilateral Orbital Decompression, Plates 129–131 )

The orbital roof is removed to allow exploration in most instances this provides adequate exposure for removal of the tumor For tumors involving the lacrimal gland or located in the lateral-inferior portion of the orbit, the lateral wall of the orbit must also be removed.

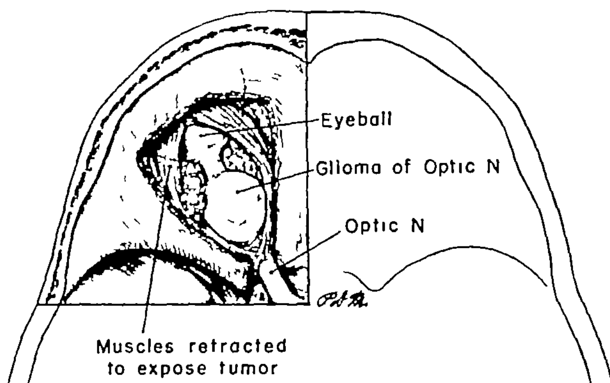
Before craniotomy is performed, a temporary tarsorrhaphy is made this is particularly important in patients with pronounced displacement of the eyeball.

Intraorbital glioma of the optic nerve the orbital roof has been removed and the ocular muscles separated, exposing the tumor

The roof of the optic canal is removed if the tumor extends into it. At times the tumor is dumbbell in shape, the posterior portion extending to the optic chiasm. In these cases the tumor is excised to the optic chiasm.

If the patient still has useful vision however simple decompression followed by x ray treatment should be instituted as an initial step

Plate 24


Eyeball
Glioma of Optic N
Optic N
Muscles retracted to expose tumor

# Part I HEAD *(Continued)*

## *Section 2* CRANIAL PROCEDURES

SKULL

# EXOSTOSIS OF SKULL

**A** Transverse incision made in the crease of the scalp

Under ordinary circumstances exostosis of the skull need not be removed, unless it is disfiguring, as when found in the frontal region.

**B** Cross section of the osteoma.

**C** Burr openings made to the inner plate.

**D** Bone between burr openings removed with a rongeur leaving the inner plate intact.

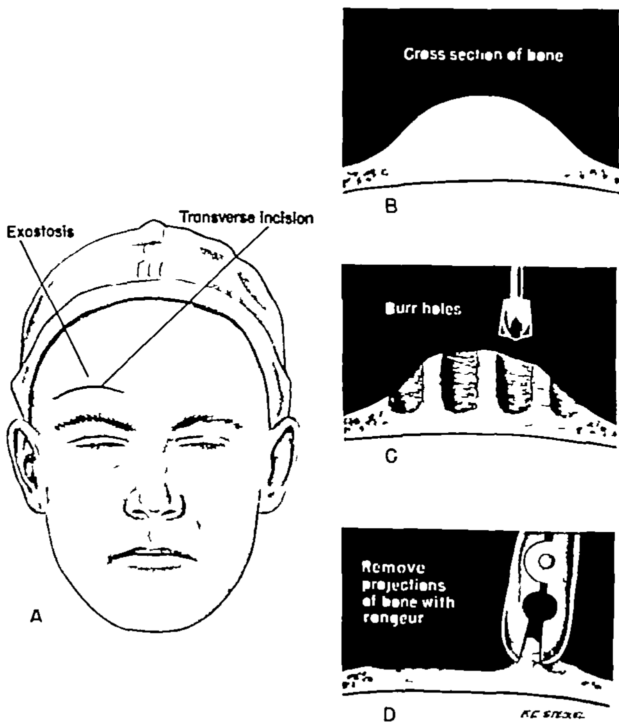

Cross section of bone
B
Transverse incision
Exostosis
Burr holes
C
Remove projections of bone with rongeur
D
A

Plate 25

A Oxycephaly

B Coronal incision with transverse extension into the temporal region.

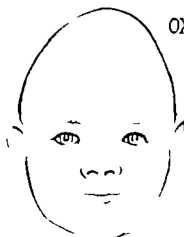
C Site of burr openings. Strips of bone 2 cm. in width connecting burr openings are removed
D with rongeurs The squamous bone is removed inferiorly

E The dura is opened through a gutter made in the bone, except in the sagittal plane.

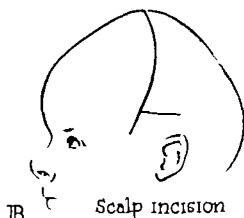
This procedure is carried out in an attempt to regain a reasonably normal contour of the skull as growth continues, with the prime objective of relieving intracranial pressure

*(Continued on Plate 27)*

## OXYCEPHALY

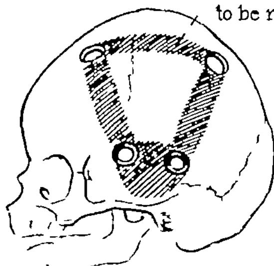


A

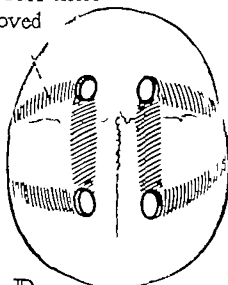



B

Areas of bone between burr holes to be removed

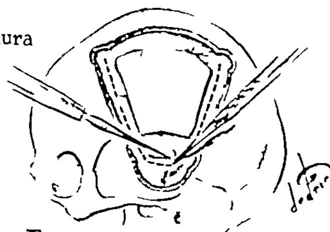


C



D

Opening dura along broken line



E

Plate 26

**F** Scaphocephaly Coronal incision with temporal extension.

**G** Areas of bone to be removed

**H** Wedges of bone removed over sagittal sinus to allow expansion over vertex.

**I** Dural incisions for decompression

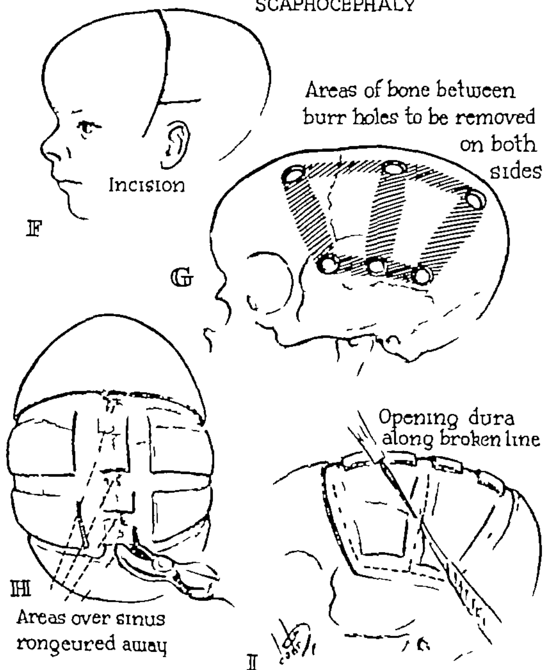

SCAPHOCEPHALY
Incision
F
Areas of bone between burr holes to be removed on both sides
G
Opening dura along broken line
H
Areas over sinus rongeured away
I

Plate 27

**A** Bone defect in the skull

**B** Gutta-percha placed over the bone defect to determine the proper size and pattern.

**C** Exact pattern placed over the tantalum plate so that a plate of the proper size can be cut

**D** Tantalum plate molded on a molding block.

**E** Drill opening made in bone edge. The size of the drill and depth are determined by the size of the tantalum screw

**F** Drill opening in the tantalum plate is countersunk.

**G** Screw head is then flush with the edge of the plate.

**H** Plate *in situ*

*(Continued on Plate 29)*

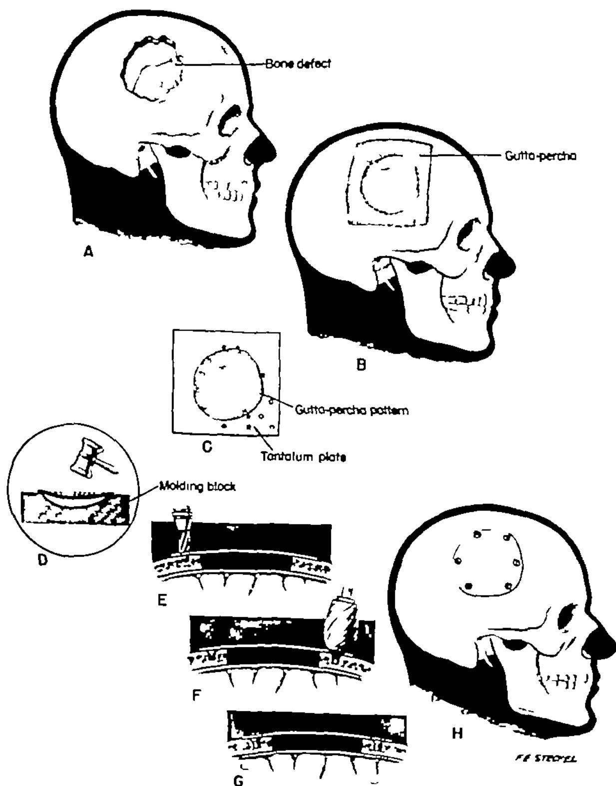

Bone defect
A
Gutta-percha
B
Gutta-percha pattern
C
Tantalum plate
Molding block
D
E
F
G
H
F.E. STECKEL

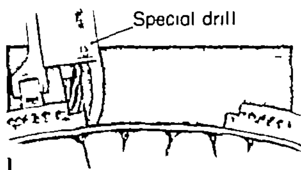
Plate 28

Plastic with acrylic material is often preferable

**I** Countersinking on a ledge the outer plate is removed with a special drill.

**J** Acrylic plate in position

The advantage of the acrylic plate is elimination of dead space between the dura and the plate The dotted lines indicate small drill openings made through the plate so that tissue can grow through these openings.



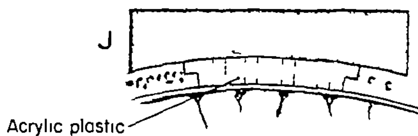




Plate 29

**A** Scalp incision should be made well away from the edges of the depressed skull fracture.

**B** Burr openings are made through healthy bone around the edges of the fracture.

**C** The lacerated dura is repaired the brain is inspected beneath the comminuted fracture.

**D** Bone flap is replaced after fragments have been everted. The scalp is sutured with a single layer of interrupted stainless steel wire.

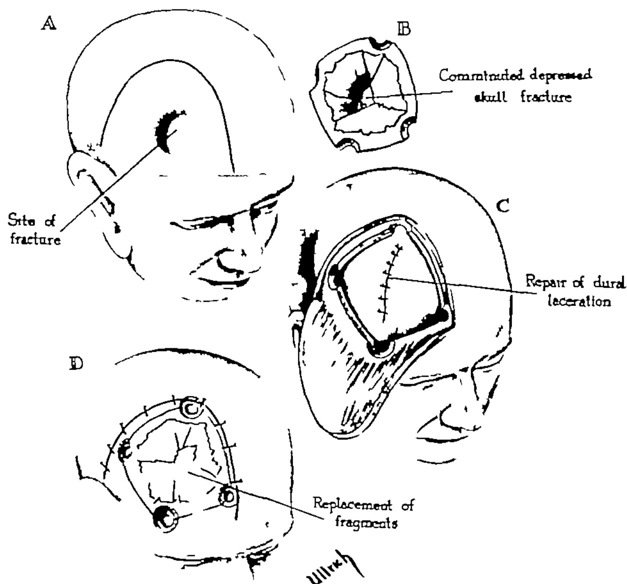

A
B
Comminuted depressed skull fracture
Site of fracture
C
Repair of dural laceration
D
Replacement of fragments
Ullrich

Plate 30

A Position of patient.

B Relative locations of scalp incisions over the parietal area approximately 4.5 cm. from the midline. The anterior incisions are outlined and the usual drapes applied Burr openings are then made over the parietal region

As the dura is exposed by burr openings made on each side, the presence or absence of a subdural hematoma can be determined by its color the dura overlying the hematoma usually has a bluish tinge. In rare instances an aberrant or accessory venous sinus may lie immediately beneath the burr opening, simulating the appearance of a subdural hematoma.

C Hematoma visible through the dura.
*Inset* (between C and D) Appearance of normal dura and of dura overlying hematoma on opposite side.

D Dura opened. The outer membrane of the hematoma is as thick as the dura at times, but definitely more friable. Chocolate-colored, liquefied contents will pour out. A catheter is inserted and the cavity washed out with normal saline solution

If partially organized material is present, hydrogen peroxide may be inserted with a syringe. This usually tends to detach the organized fragments. Care must be taken to avoid aspirating the foam that results from the insertion of hydrogen peroxide, since the suction tube will become clogged. It is better to wait for a minute or two and then wash it out thoroughly with saline solution.

E Cross section with catheter in the hematoma cavity The relative thickness of the outer and inner membranes is shown, with displacement of the cerebral hemisphere.

F *Catheter remains in cavity for twenty-four to forty-eight hours.*

The two anterior incisions shown in B are opened only if hematomas are not found in the parietal area.

If the hematoma has been present for several months, the brain does not expand immediately Expansion takes place gradually in three or four days, and the degree of expansion can be verified by postoperative roentgenograms. The cavity resulting from the evacuation of a hematoma is always filled with air consequently an excellent indication of the degree of expansion that occurs can be visualized by anteroposterior x-ray films made on successive days.

If the hematoma is completely organized, it can be removed either through a subtemporal decompression site or through an enlargement of the burr openings.

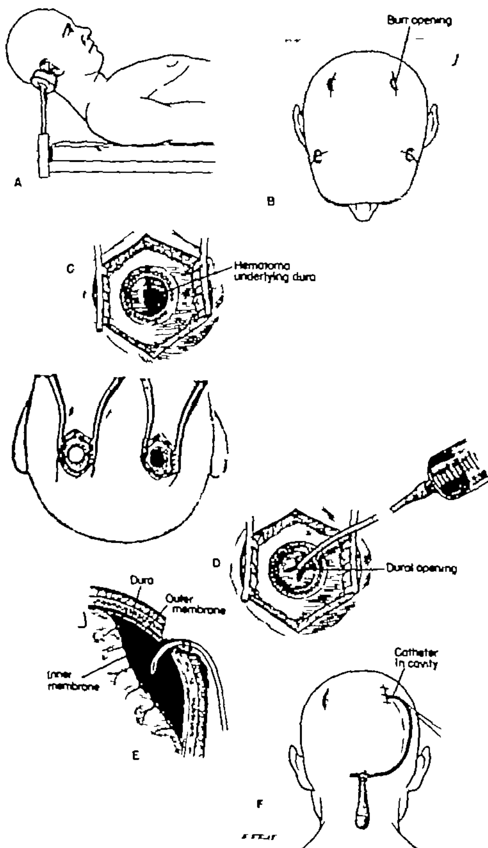

Burr opening
A
B
C
Hematoma underlying dura
D
Dural opening
Dura
Outer membrane
Inner membrane
E
Catheter in cavity
F

Plate 31

**A** Extradural hematoma with displacement of cerebral tissues.

**B** Line of incision is that used in Sensory Root Operations (Plate 14) a similar exposure is made.

**C** Fracture line burr openings made outline of the squamous portion of the temporal bone to be removed.

*(Continued on Plate 33)*

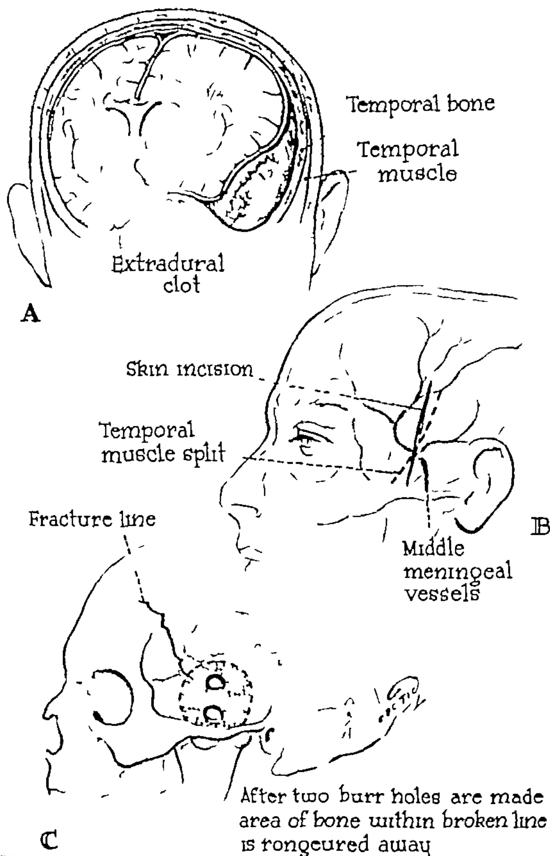

Temporal bone
Temporal muscle
Extradural clot
A
Skin incision
Temporal muscle split
Fracture line
B
Middle meningeal vessels
After two burr holes are made area of bone within broken line is rongeured away
C

Plate 32

D Clot removed with suction

E Temporal dura elevated foramen spinosum occluded with a small wisp of cotton inserted with a nerve hook and foramen covered with wax.

Meningeal vessels may also be occluded with the electrosurgical unit. All bleeding points are carefully controlled.

F Closure. Catheter which drains into a thin rubber bag, is removed in twenty-four hours



Plate 33

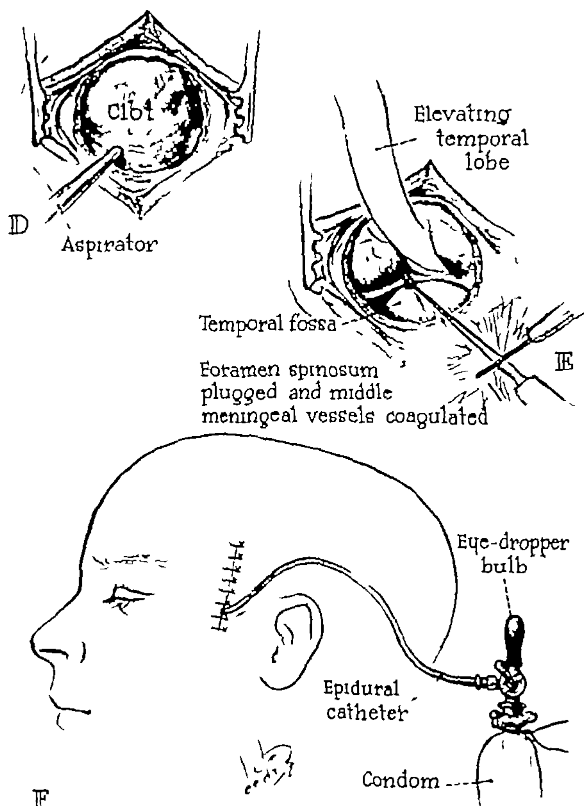

Clot
D
Aspirator
Elevating temporal lobe
Temporal fossa
Foramen spinosum plugged and middle meningeal vessels coagulated
E
Eye-dropper bulb
Epidural catheter
Condom
F

Plate 33

**A** Completely ossified subdural hematoma lying along the falx and extending over the medial surface of the cerebral hemisphere.

*Inset* Ossified hematoma removed.

**B** Cavity remaining after the hematoma has been removed, demonstrating greatly increased vascularity of the cortical tissues

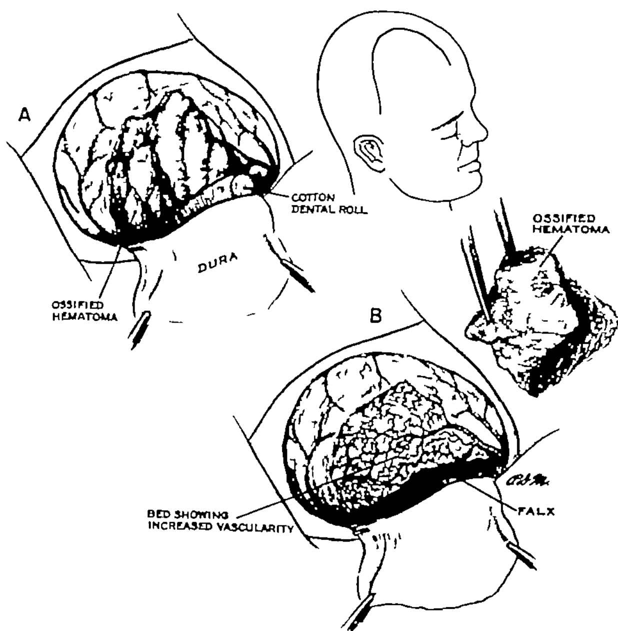

A
COTTON
DENTAL ROLL
OSSIFIED
HEMATOMA
DURA
OSSIFIED
HEMATOMA
B
BED SHOWING
INCREASED VASCULARITY
FALX

Plate 34

The patient is placed on the operating table in a supine position

**A** A small area of scalp is prepared in each temporoparietal region.

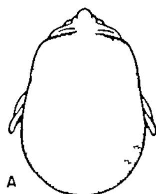
**B** After the site for insertion of the burr openings has been determined, impressions are made on the scalp with tongs.

**C** The scalp area is anesthetized with local infiltration of procaine.

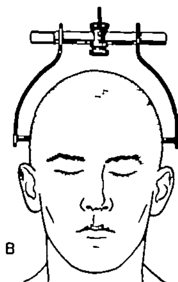
**D** A stab incision is made.

**E** The periosteum is freed

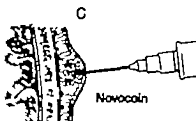
*(Continued on Plate 36)*

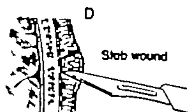



Head shaved and prepped




Center the tongs directly above the ears. Tighten to mark the spots



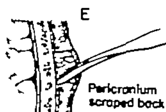




Plate 35

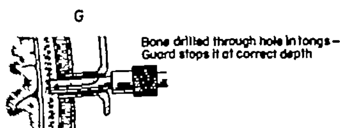
# CERVICAL TRACTION WITH VINKE TONGS

The execution of the procedure is adequately described in the labeled steps.

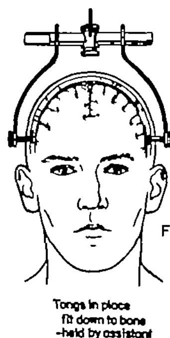
Traction may be used in any type of bed with the patient in a supine position, oblique or upright. A specialized type of bed (as indicated in J) is not necessary



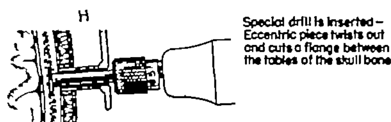
)


G

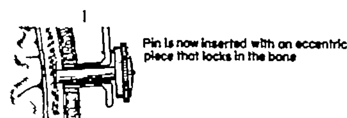
Bone drilled through hole in tongs - Guard stops it at correct depth


F

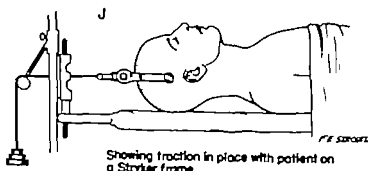
Tongs in place fit down to bone -held by assistant


H

Special drill is inserted - Eccentric piece twists out and cuts a flange between the tables of the skull bone


I

Pin is now inserted with an eccentric piece that locks in the bone


J

Showing traction in place with patient on a Stryker frame

Plate 36

# Part I HEAD *(Continued)*

## *Section 3* INTRACRANIAL PROCEDURES

### Cerebral Tumors



*(Continued on Pages 78 and 79)*

(*Concluded on Page 79*)

## PART I SECTION 3 CONTENTS

# LARGE HYPEROSTOSING MENINGIOMA

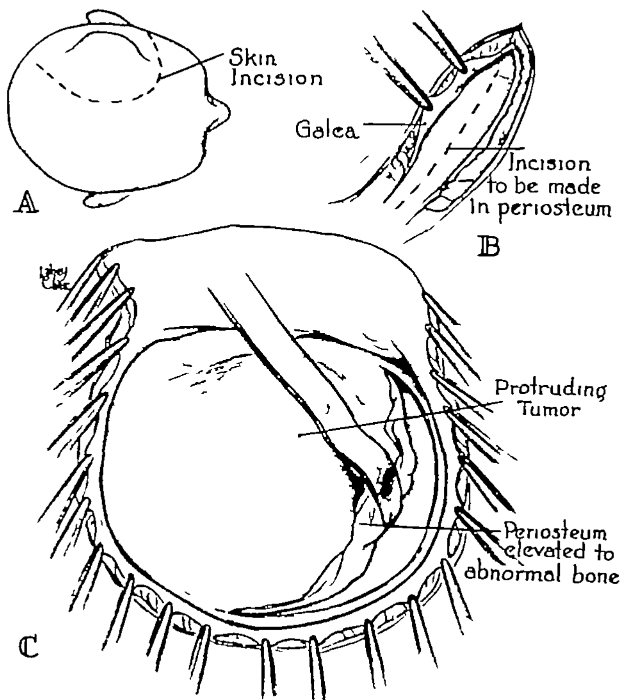
This procedure is suitable for the large hyperostosing meningioma, involving mostly bone, periosteum and dura, with slight intradural extension. It is also applicable to the large solitary tumor involving bone, periosteum and dura, and depressing but not invading brain tissue.

**A** Location of tumor and line of incision.

**B** Galea separated from periosteum.

**C** Scalp flap reflected periosteum incised.

*(Continued on Plates 38 and 39)*

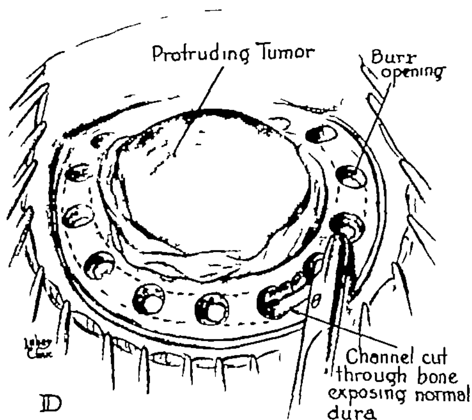

Skin Incision
A
Galea
Incision to be made in periosteum
B
Protruding Tumor
Periosteum elevated to abnormal bone
C

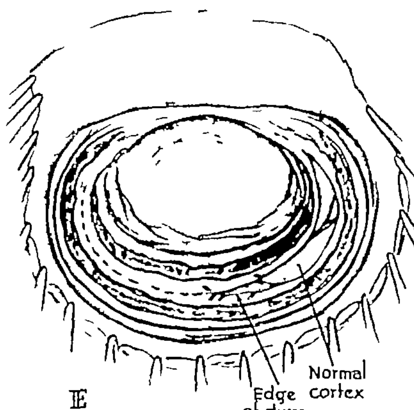
**D** Multiple burr openings made encircling the tumor mass.

The extent of bone involved with the tumor can be determined in this manner and the intervening bone between the burr openings can be easily removed with a wide rongeur Because of brisk bleeding from the burr openings as the bone is removed with rongeurs, it may be necessary at times to insert large temporary plugs of wax while proceeding with the removal of bone.

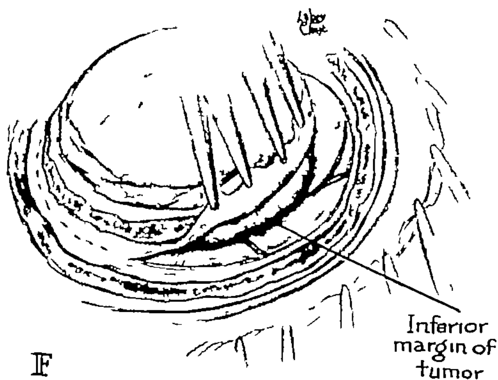
**E** Dura incised, encircling the entire tumor mass

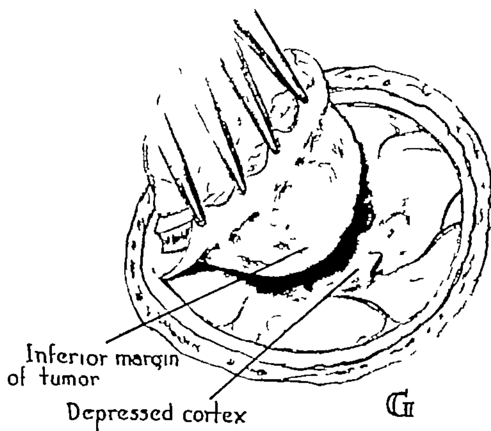
*(Continued on Plate 39)*


Protruding Tumor
Burr opening
Channel cut through bone exposing normal dura
D


Normal cortex
Edge
E

F
G
Completion of operative procedure. The dural defect is again closed with the periosteal graft or dural artificial substitute. The bony defect is repaired with either tantalum plate or plastic material and the scalp flap resutured.


Inferior margin of tumor
F


Inferior margin of tumor
Depressed cortex
G

Convexity meningiomas with a broad dural attachment may be surgically extirpated without decreasing bulk by the use of the electrosurgical unit.

A Meningioma with a broad dural attachment enostosis

B Type of scalp incision and bone flap The enostosis is completely drilled out to the outer plate.

If the outer plate is also involved with tumor the entire area is removed and replaced by a bone, stainless steel or acrylic plate.

The dura is incised at right angles to the tumor well away from its edge in this way the exact extent of dural involvement can be determined. The dura is then incised, encircling the tumor care is taken that no tumor is allowed to remain attached to the dural edges.

Meningiomas that have a broad base can be removed intact without exerting excessive traction on the cortical tissues.

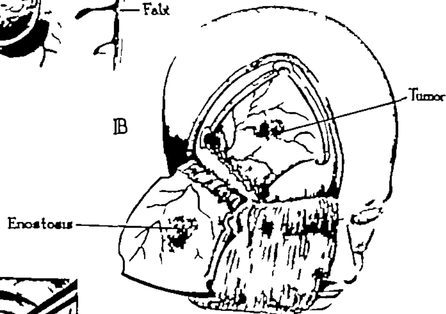
C Arachnoidal attachment to the tumor mass has been coagulated immediately over the tumor edge and then brushed aside, most of the traction being exerted on the tumor itself rather than on the cortical tissues.

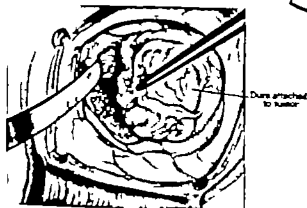
All entering vessels are individually sealed off with the electrosurgical unit. For this reason it may be necessary to encircle the tumor completely two or three times at various depths.

*(Continued on Plate 41)*

# MENINGIOMA OF THE CONVEXITY



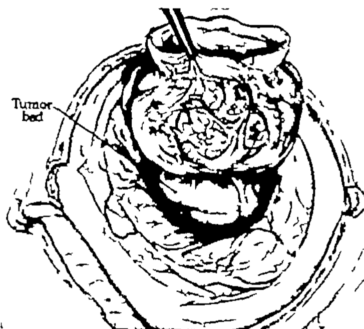
**D** The tumor is then lifted from its bed and the vessels attached to the inferior surface are occluded and divided.

**E** The tumor is removed A large cotton ball is immediately inserted into the tumor cavity the ball should fill the entire cavity A glass suction tube is applied to the cotton ball

As the cotton ball is gently removed, the smaller cortical vessels in the brain tissue are coagulated against the cotton as they come into view while the cotton ball is being elevated.

The dura is repaired either with a periosteal graft obtained from the scalp flap or with a dural substitute.

If the cavity is large, catheter drainage is instituted for a period of two or three days.




D

Meningioma

Dura

E

Tumor bed

# SUBMERGED OR "ICEBERG" TYPE OF MENINGIOMA

Such a meningioma involves only a small portion of the dura.

**A** Cross section of the submerged type of meningioma with a narrow attachment to the dura. The cortex covers the bulk of the tumor with the exception of the small narrow neck.

**B** An osteoplastic bone flap is turned down the dura is incised well away from the tumor at right angles until tumor tissue is encountered. The dura is then opened, encircling the attached tumor

**C** The tumor should be scooped out with the electrosurgical unit, allowing only a shell of tumor to remain

If the tumor were removed in one mass, the cortex overlying the submerged tumor would be damaged considerably

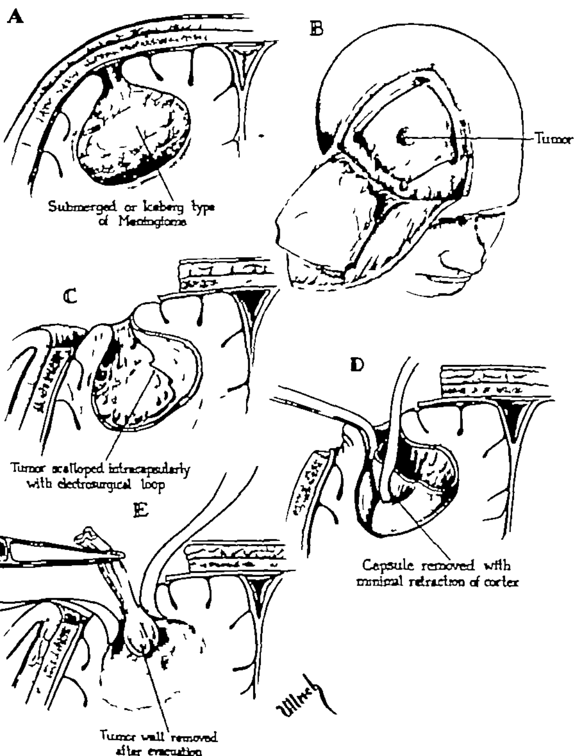
**D** The tumor wall can then be removed and brought out through a relatively small cortical opening.

In this manner trauma to the surface brain tissue is kept at a minimum.

**E** The capsule of the evacuated tumor is delivered from its bed.

The dural opening is closed with a dural substitute or with a portion of galea excised from the scalp flap, *as demonstrated in Technique for Obtaining Dural Graft from Scalp Flap (Plate 113)*

SUBMERGED OR "ICEBERG" TYPE OF MENINGIOMA



# OLFACTORY GROOVE OR CRIBRIFORM PLATE MENINGIOMA

**A** Outline of bone flap and location of tumor from anterior view

**B** Position of the patient head slightly extended, body in a moderate Fowler's position.

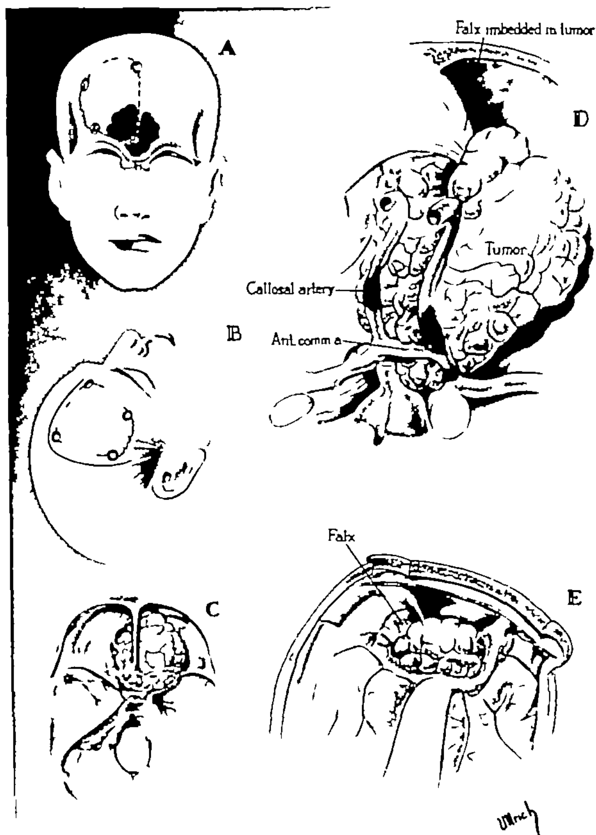
**C** Tumor in relation to the floor of the skull and the anterior fossa.

**D** Oblique view of the tumor demonstrating the groove made in the tumor by the falx, posterior displacement of the callosal arteries and downward compression of the optic chiasm.

**E** Greatly thinned shell of the frontal lobe removed, exposing the tumor

*(Continued on Plates 44 and 45)*

# OLFACTORY GROOVE OR CRIBRIFORM PLATE MENINGIOMA



**F** Larger vessels over the capsule of the tumor have been coagulated and the tumor gutted with electrosurgical unit.

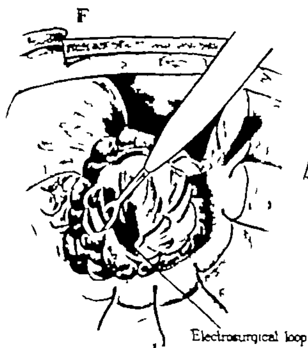
At the time of the looping, a glass suction tube is kept in the excised portion of the tumor. This greatly facilitates the looping with the electrosurgical knife, by preventing excess eschar formation on the loop and excessive transmission of heat, and by keeping the field free from blood at the point that the scalloping takes place.

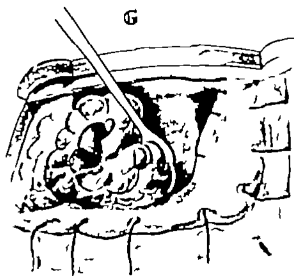
**G** Bleeding points carefully controlled. The anterior medial wall of the tumor is retracted posteriorly away from the bony attachment to the cribriform plate. The bleeding points in the bone are controlled with wax.

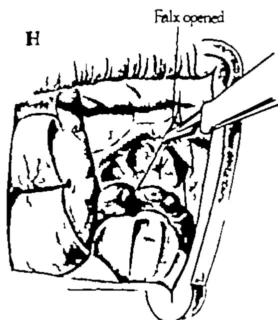
**H** Falx incised and a wedge-shaped portion removed

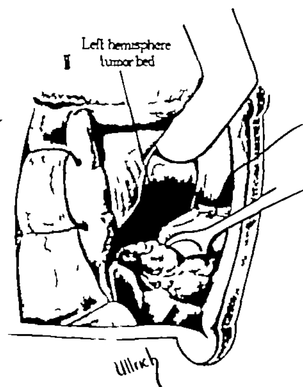
**I** This allows the medial retraction of the shallow tumor wall, which has made a deep nest in the medial position of the opposite hemisphere.

*(Continued on Plate 45)*


F
Electrosurgical loop


G


H
Falx opened


I
Left hemisphere
tumor bed

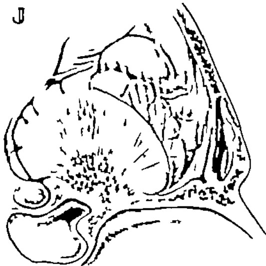
**J** Bony attachment over the cribriform plate.

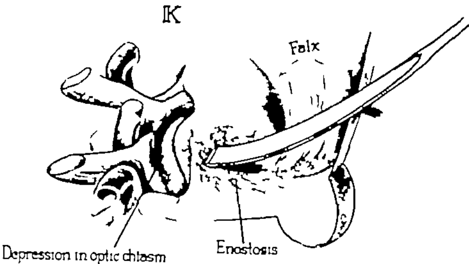
**K** Involved bony enostosis removed with a chisel to prevent recurrence.

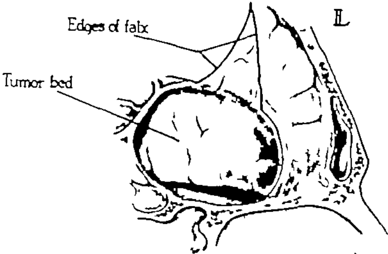
**L** Cavity after removal of tumor

If in the removal of the bony enostosis the mucous membranes of the ethmoid sinuses are exposed these should be reinforced to prevent rhinorrhea. (Refer to Cerebrospinal Rhinorrhea Surgical Treatment, Plates 139–141.)

OLFACTORY GROOVE OR CRIBRIFORM PLATE MENINGIOMA



# PARASAGITTAL MENINGIOMA

## Associated with Enostosis and Involving the Lateral Portion of the Sagittal Sinus

A Type of scalp incision bone flap turned down well across the midline.

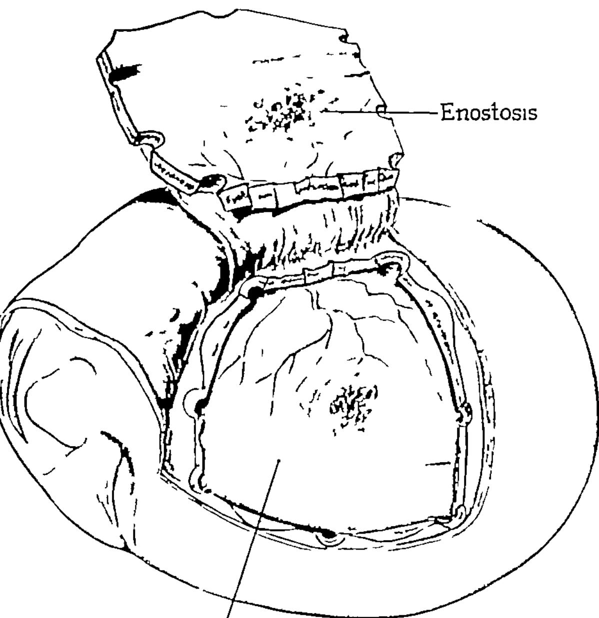
In this particular instance the enostosis readily separates from the tumor

Anterior and posterior burr openings are made on each side of the sagittal sinus and are connected with a Montenovesi rongeur rather than with the Gigli saw

(*Continued on Plates 47 48 and 49*)

## PARASAGITTAL MENINGIOMA

Associated with Enostosis and Involving the Lateral Portion of the Sagittal Sinus




A

Ullrich

## PARASAGITTAL MENINGIOMA

### Associated with Enostosis and Involving the Lateral Portion of the Sagittal Sinus

**B** The enostosis is deeply imbedded in the tumor proper and involves the lateral portion of the sagittal sinus.

In this particular instance, allowing the involved bone to remain *in situ* immediately over the tumor (as shown) is preferable. The bone may be either removed with a periosteal elevator after the bone flap has been turned down or allowed to remain while the tumor is being removed.

(*Continued on Plates 48 and 49*)

# PARASAGITTAL MENINGIOMA

Associated with Enostosis and Involving the Lateral Portion of the Sagittal Sinus

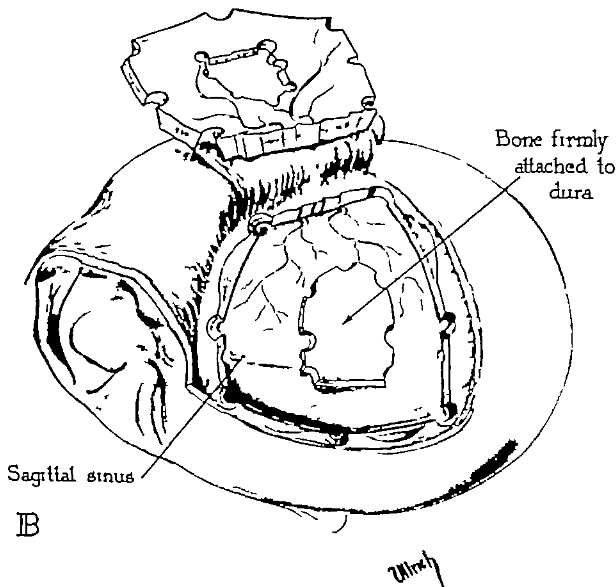



Plate 47

# PARASAGITTAL MENINGIOMA

## Associated with Enostosis and Involving the Lateral Portion of the Sagittal Sinus

**C** Tumor completely encircled with a dural incision which leaves only a small margin of normal dura attached to tumor

**D** Cross section parasagittal meningioma involving the bone and lateral wall of the sagittal sinus.

**E** Tumor removed from its bed, allowing the medial portion of the dural flap attached to the lateral margin of the sagittal sinus to remain intact.

**F** Curved hemostats occlude the lateral margin of the sagittal sinus. As each hemostat is applied, the healthy dural edges of the sinus are divided with scissors.

**G** After excision of the tumor interrupted black silk sutures are inserted as the ligature is tied, *each hemostat is removed.*

**H** Completion of closure of the edges of the sinus leaving the major channel intact.

The dural defect is repaired with a periosteal or artificial graft. The tumor invading the inner plate of the bone flap is removed with the electric drill to the external plate if this plate is not involved with tumor If tumor has invaded the external plate, the defect is closed with an artificial bone graft.

The scalp is closed with a single layer of end-on mattress stainless steel wire.

*(Continued on Plate 49)*

# PARASAGITTAL MENINGIOMA

## Associated with Enostosis and Involving the Lateral Portion of the Sagittal Sinus

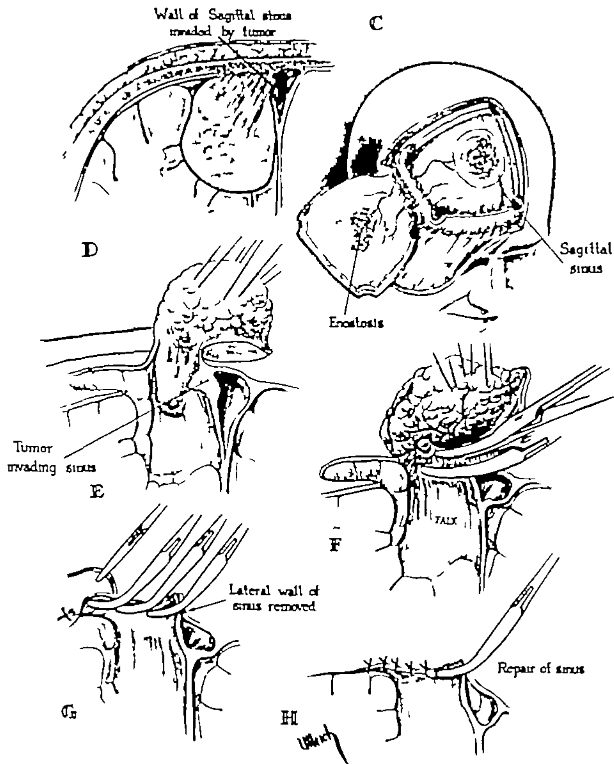



Plate 48

# PARASAGITTAL MENINGIOMA

## Associated with Enostosis and Involving the Lateral Portion of the Sagittal Sinus

Meningioma extending to the edge of the lateral sinus but not involving the wall.

I Bone flap turned down from well across the midline dura incised around the tumor to the wall of the sinus.

J Tumor removed from its bed.

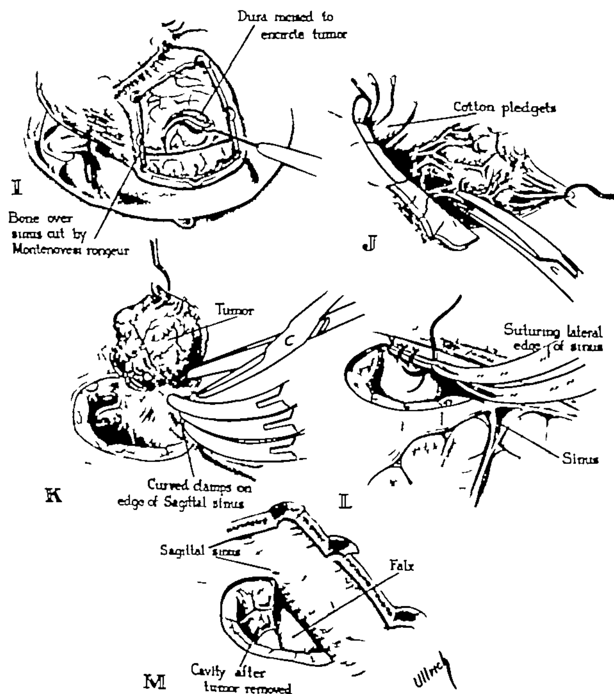
K Curved hemostats placed along the lateral edge of the sagittal sinus.

L Fine silk sutures placed along the edge of the sagittal sinus.

M Tumor cavity and surrounding structures. Dural defect is repaired

# PARASAGITTAL MENINGIOMA

## Associated with Enostosis and Involving the Lateral Portion of the Sagittal Sinus



# HYPEROSTOSING SPHENOID WING MENINGIOMA

During the introduction of anesthesia considerable care should be exercised to protect the cornea of the exophthalmic eye. After the patient has been anesthetized, the eyelids are closed by temporary interrupted mattress sutures. (Refer to Malignant Exophthalmos Temporary Canthorrhaphy Plate 127.)

**A** Line of incision. The sagittal portion of the incision should lie in the exact midline and be brought down in the form of a question mark to the zygomatic process

**B** Bone flap outline.

**C** Greatly thickened squamous portion of the temporal bone is removed by making multiple burr openings, as demonstrated, so that the severely eburnated bone can be readily removed. Burr openings are also made over the thickened portion of the orbital plate to facilitate removal of the plate with rongeurs.

*(Continued on Plates 51 and 52)*

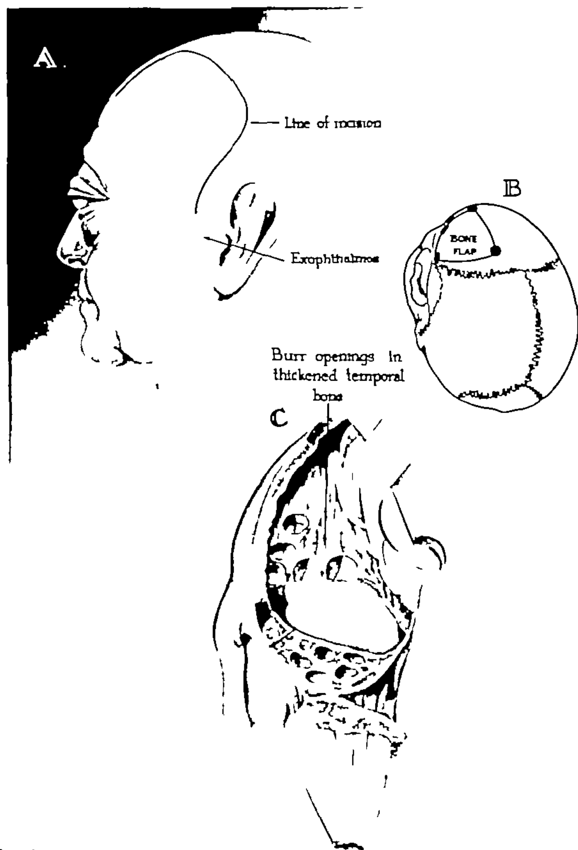

A.
Line of incision
Exophthalmos
B
BONE FLAP
Burr openings in thickened temporal bone
C

Plate 50

D Compression of the orbital contents causing the exophthalmos method of removal of the greatly thickened, eburnated bone.

E Solid intracranial tumor

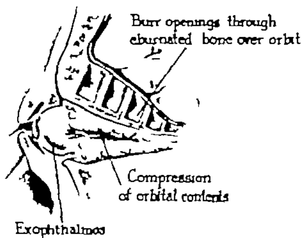
In most instances the tumor associated with the hyperostosing sphenoid wing meningioma is *en plaque* rather than a globular type. At times, however a solid tumor does extend intracranially and should be excised.

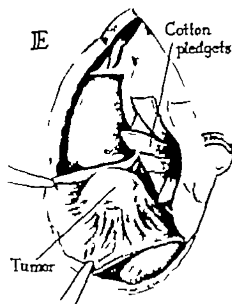
F Dural graft sutured into the defect.

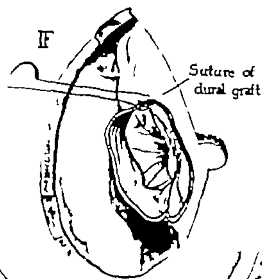
G Cotton pledgets removed and dura completely closed.

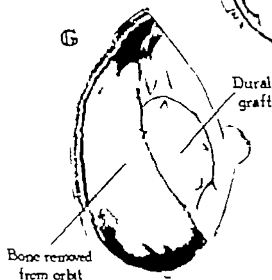
H Recession of the eyeball and decompression of the orbital tissues after removal of the orbital plate.

*(Continued on Plate 52)*


D
Burr openings through eburnated bone over orbit
Compression of orbital contents
Exophthalmos


E
Cotton pledgets
Tumor


F
Suture of dural graft


G
Dural graft
Bone removed from orbit

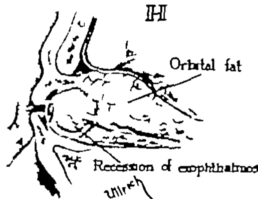

H
Orbital fat
Recession of exophthalmos

Plate 51

If the anterior clinoid is also involved, it should be removed

I *Greatly thickened anterior clinoid honeycombed with a special drill.*

*Inset* Removal of the interlacing bone left by the burr openings with chisel and mallet.

J Orbital fascia opened to determine whether meningioma *en plaque* is present intraorbitally

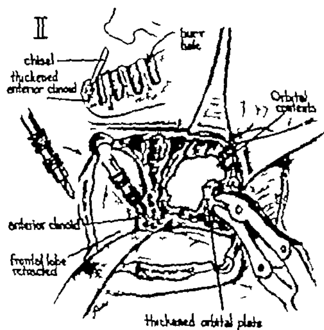
K If tumor is present, the orbital fascia involved by the tumor should be completely excised

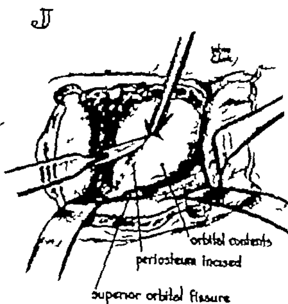
L Frontotemporal dura along the sphenoid wing involved with a layer of tumor—the so-called meningioma *en plaque*

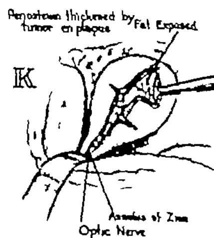
The dura should be separated from the anterior portion of the temporal fossa, and the dura involved with the tumor should be completely excised. If only a small area of dura is invaded by tumor it may be destroyed with electrocoagulation however complete excision of this area is preferable.

The temporal muscle is also occasionally invaded by tumor If this occurs, the muscle can be readily excised.

The usual closure is made and a catheter allowed to remain in the cavity for twenty-four to thirty-six hours. The temporary lid suture is removed as soon as the postoperative edema has subsided.


I
chisel
thickened anterior clinoid
burr hole
Orbital contents
anterior clinoid
frontal lobe retracted
thickened orbital plate


J
orbital contents
periosteum incised
superior orbital fissure


Periosteum thickened by tumor en plaque
Fat Exposed
K
Annulus of Zinn
Optic Nerve

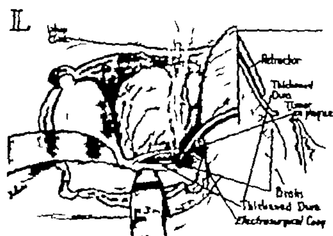

L
Retractor
Thickened Dura
Tumor en plaque
Brain
Thickened Dura
Electrosurgical Coag

Plate 52

# MENINGIOMA OF THE POSTERIOR CLINOID AND SELLA TURCICA
## TEMPORAL APPROACH

A Temporal approach type of incision The squamous portion of the temporal bone is removed through the vertical incision. Sufficient room is usually obtained without opening the posterior line of incision. The bone flap (outlined) is turned down only if exposure through the original opening is inadequate.

B Anterior incision only opened as in operation for Trigeminal Neuralgia (Plate 14)

C Normal anatomic structures.

D Meningioma of the clivus, displacing the pons posteriorly partially obstructing the aqueduct of Sylvius, and extending superiorly into the third ventricle. The optic chiasm is prefixed making it impossible to approach the tumor anteriorly

E Temporal lobe elevated, exposing tumor The third cranial nerve may be displaced laterally as well as posteriorly or it may be carried superiorly with the tumor and greatly stretched.

F Relationship of distorted structures after removal of tumor

# MENINGIOMA OF THE POSTERIOR CLINOID AND SELLA TURCICA, TEMPORAL APPROACH

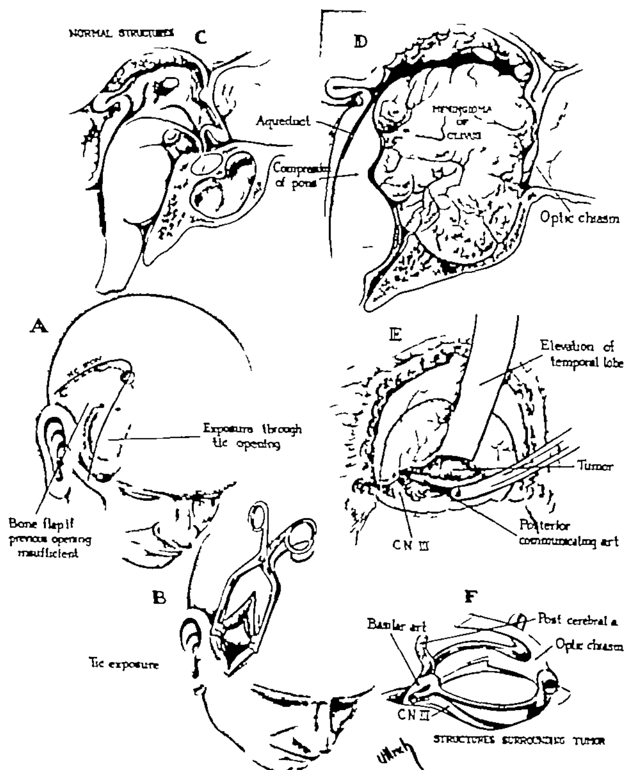



Plate 53

# CHORDOMA PARASELLAR, SELLAR AND POSTERIOR CLINOID TEMPORAL APPROACH

Chordomas are exposed in the same manner as craniopharyngiomas and pituitary adenomas with a prefixed chiasm (Refer to Large Craniopharyngioma with Prefixed Chiasm Temporal Approach, Plate 58 )

A Relationship of chordoma to sella pons and anterior third ventricle with a prefixed optic chiasm erosion of posterior clinoid and upper portion of clivus.

B Relationship to blood vessels and chiasm lateral view

C Relationship to blood vessels and chiasm, posterior view

D Tumor completely extradural

> Thus the tumor can be extirpated extradurally with the incision made through the capsule just above the cavernous sinus.

Tumors involving the posterior clinoid the upper portion of the clivus or the sella turcica that are limited anteriorly by the chiasm of the optic nerve, posteriorly by the pons and superiorly by the third ventricle should be attacked by the temporal route. This is especially true if the chiasm of the optic nerve is prefixed.

CHORDOMA PARASELLAR, SELLAR AND POSTERIOR CLINOID
TEMPORAL APPROACH

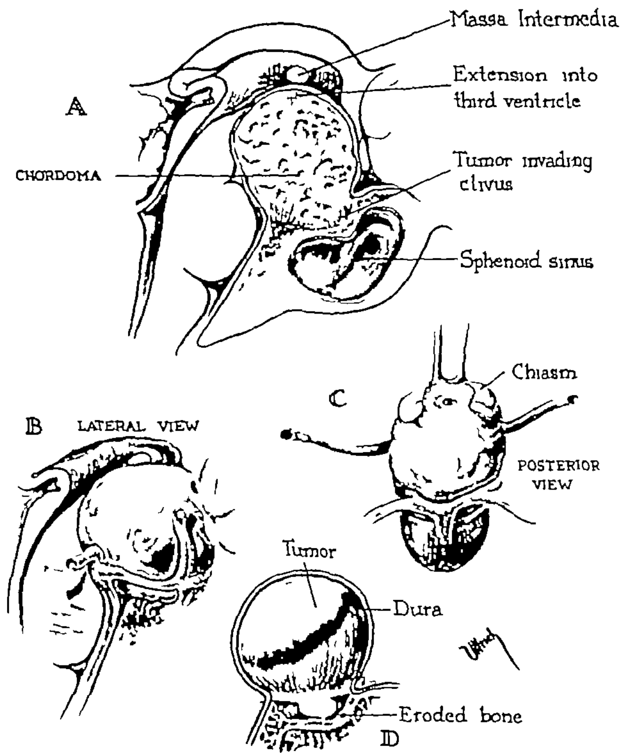



Plate 54

# CHROMOPHOBE AND CHROMOPHIL PITUITARY ADENOMAS
## FRONTAL APPROACH

An incision is made similar to that demonstrated in Hypophysectomy (Plate 56), up to the point of exposure of the adenoma.

*Top inset* Type of incision made in the dura single curvilinear opening with the anterior flap attached with interrupted silk sutures to the galea of the scalp flap.

The chiasm is fixed and the adenoma is shown protruding between the stretched optic nerves. The small vessels over the capsule of the adenoma are sealed off with the electrosurgical unit and a portion of the capsule is removed with a sharp-pointed knife.

A Contents are then evacuated with a pituitary scoop.

B Further evacuation of contents by suction.

C Removal of the redundant capsule.

Care must be taken to control all bleeding points before closure is made

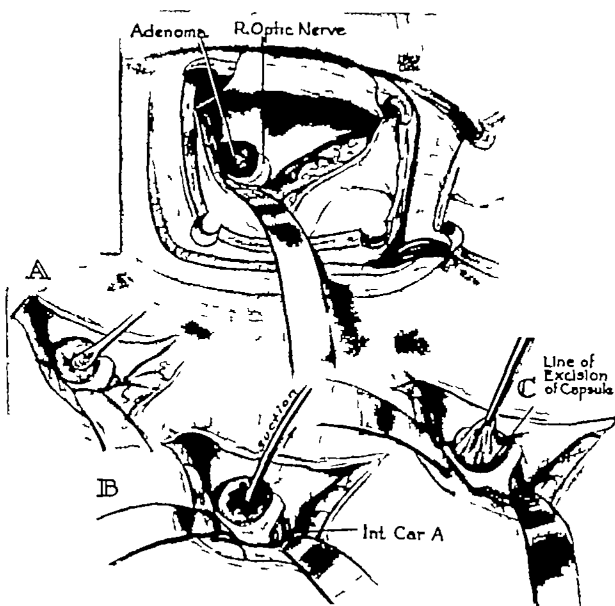

Adenoma
R. Optic Nerve
A
B
Suction
Int. Car A
C
Line of Excision of Capsule

Plate 55

# HYPOPHYSECTOMY

As the patient is being draped for frontal craniotomy under intratracheal anesthesia, spinal fluid may be withdrawn from the lumbar canal or urea solution given intravenously If urea solution is instituted, an indwelling catheter in the bladder is important.

**A** With the patient in Fowler s position and the head slightly flexed a frontal scalp flap is reflected and a bone flap turned down in the location outlined

**B** The dura is opened with the pedicle placed anteriorly with a slightly curved incision and sutured to the scalp flap for traction The frontal lobe is then slowly elevated allowing as much cerebrospinal fluid as possible to escape. The right optic nerve is identified

**C** The arachnoid of the prechiasmatic cistern is opened The right and left optic nerves, as well as the anterior portion of the chiasm and the pituitary stalk, are visualized

**D** The stalk is coagulated and divided

**E** If the natural opening of the diaphragm of the sella turcica is not sufficiently large, an incision is made in a stellate fashion, care being taken not to enter the venous sinuses.

**F** The diaphragm of the sella turcica is opened widely

*(Continued on Plate 57)*

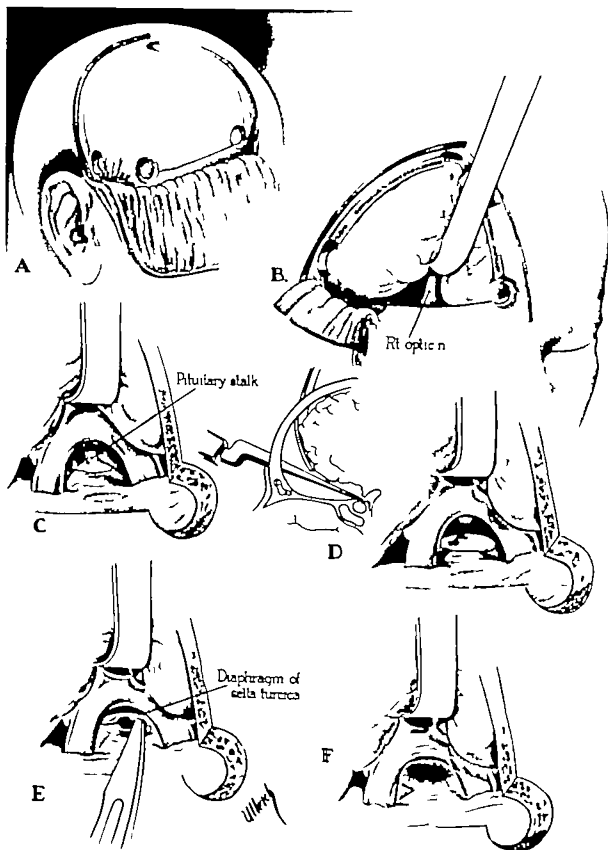

A
B.
Rt optic n
Pituitary stalk
C
D
Diaphragm of
sella turcica
E
F

Plate 56

G An open pituitary scoop is inserted to the posterior clinoid freeing the capsule if possible.

If the tuberculum of the sella projects posteriorly the capsule cannot be freed from its anterior wall initially without removing the bony projection. On the other hand if no projection is present, the dissection can be started anteriorly and the pituitary body removed intact.

H If it is necessary to remove the pituitary body piecemeal, the capsule must be removed

I After total enucleation small bleeding places occasionally occur Gelfoam is inserted into the cavity and allowed to remain against the walls of the sella light pressure is applied for a few minutes

J Excess Gelfoam is removed after the oozing has stopped

A catheter is inserted into the sella and the usual dural closure made. The catheter is removed in twenty-four to forty-eight hours

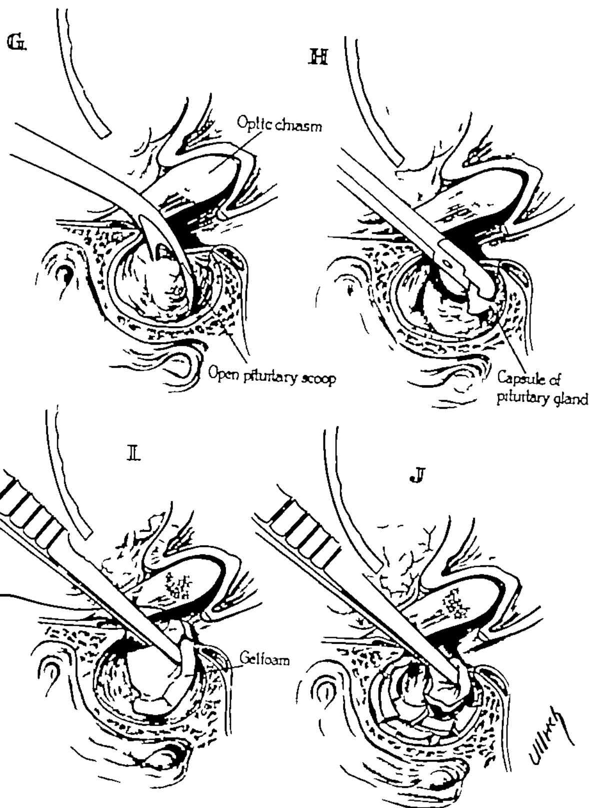

G
H
Optic chiasm
Open pituitary scoop
Capsule of pituitary gland
I
J
Gelfoam

Plate 57

# LARGE CRANIOPHARYNGIOMA WITH PREFIXED CHIASM
# TEMPORAL APPROACH

**A** Type of incision. The squamous portion of the temporal bone is removed through the vertical incision.

This approach is used with patients with severe internal hydrocephalus. Usually sufficient exposure can be obtained without turning the bone flap as outlined The posterior line of incision does not have to be opened unless it is necessary to turn down the bone flap as well as remove the bone with rongeurs.

**B** Temporal lobe elevated and exposure made, showing the right optic nerve displaced anteriorly and the positions of the carotid artery and the third cranial nerve. The capsule of the tumor is opened.

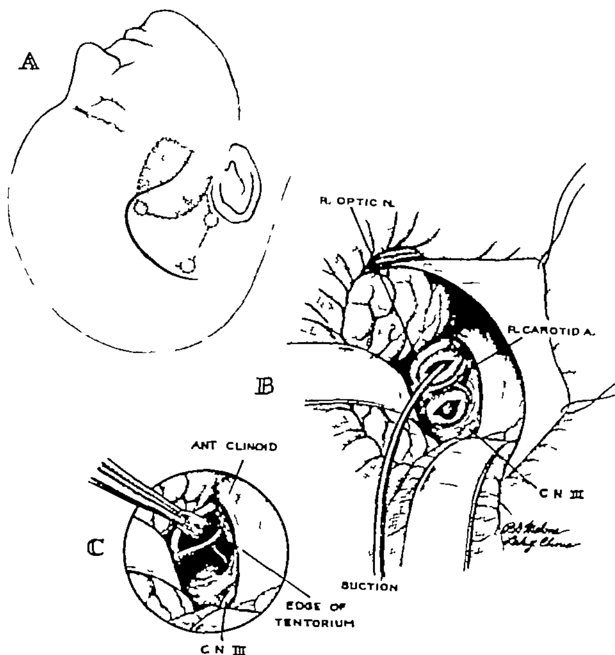
If the contents are merely cystic, the capsule readily separates from the inferior portion of the third ventricle and the surrounding tissues and can be removed piecemeal or in one segment. On the other hand if the tumor consists of a considerable amount of solid tissue, it can be removed intracapsularly

**C** Complete extirpation of capsule.

This step was possible in this particular operation

*(Continued on Plate 59)*

# LARGE CRANIOPHARYNGIOMA WITH PREFIXED CHIASM
TEMPORAL APPROACH



# LARGE CRANIOPHARYNGIOMA WITH PREFIXED CHIASM
# FRONTAL APPROACH

Postmortem examination showing the difficulties encountered in the frontal approach to craniopharyngioma. Portions of the right frontal lobe were resected and the right optic nerve was divided A very incomplete intracapsular enucleation was possible The temporal approach is preferable in this type of condition

## LARGE CRANIOPHARYNGIOMA WITH PREFIXED CHIASM
## FRONTAL APPROACH



Plate 59

# GLIOMA FRONTAL LOBECTOMY

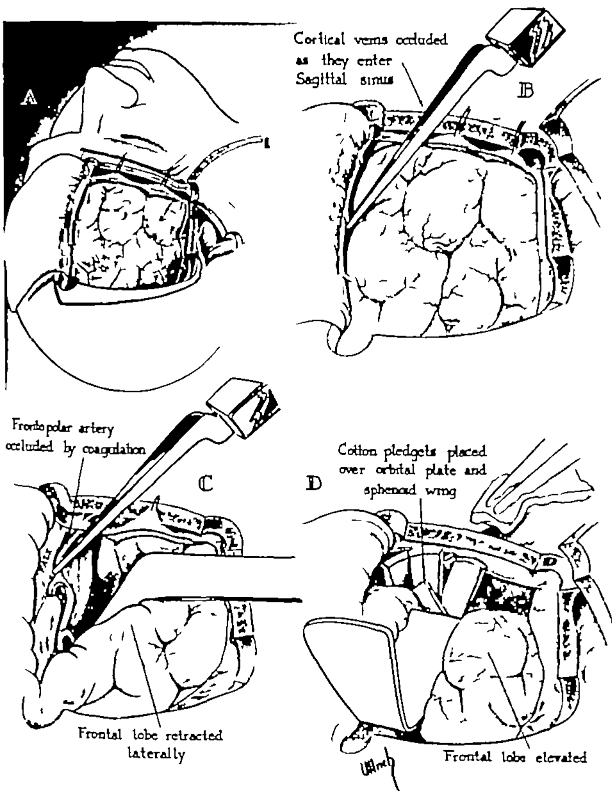
**A** Exposure with the dura turned medially and the base of the pedicle at the level of the sagittal sinus.

**B** The cortical veins are occluded and divided with the electrosurgical unit.

**C** The frontal lobe is retracted from the midline the branches of the frontopolar artery are divided

**D** The frontal lobe is elevated from the orbital plate cotton pledgets are inserted to the level of the sphenoid wing.

*(Continued on Plate 61)*


A
Cortical veins occluded as they enter Sagittal sinus
B
Frontopolar artery occluded by coagulation
C
Frontal lobe retracted laterally
Cotton pledgets placed over orbital plate and sphenoid wing
D
Frontal lobe elevated

E The vessels of the pia arachnoid are occluded with the electrosurgical unit and incised posterior to the enlarged convolutions

F Dissection is carried out with the suction-coagulation unit. Care is taken to stay within normal tissue well behind the tumor invaded area.

G The frontal lobe is removed orbital plate and falx are exposed

H The dura is closed watertight and bone flap replaced A drainage tube is placed in the cavity The scalp is sutured in the usual manner with one layer of end-on interrupted mattress sutures of stainless steel wire.

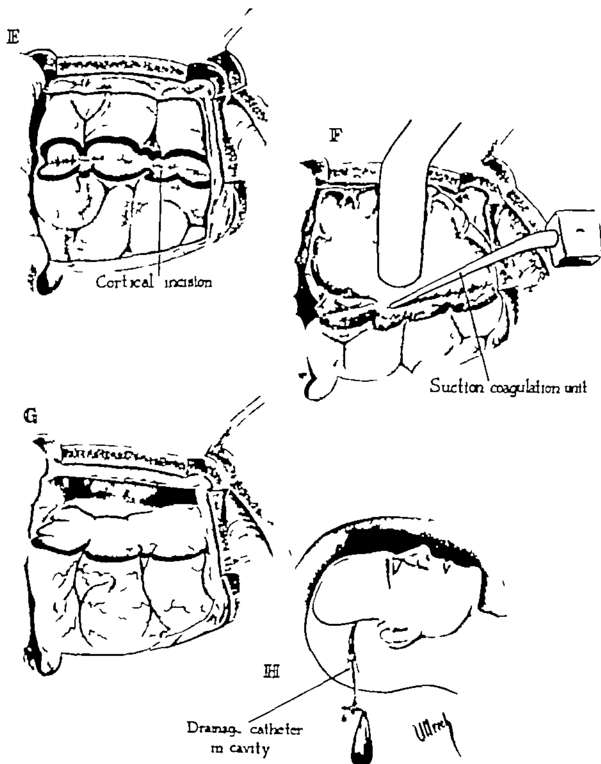

E
Cortical incision
F
Suction coagulation unit
G
H
Drainage catheter
in cavity

Plate 61

# PINEALOMA

**A** Site of tumor dilated lateral ventricle scalp incision.

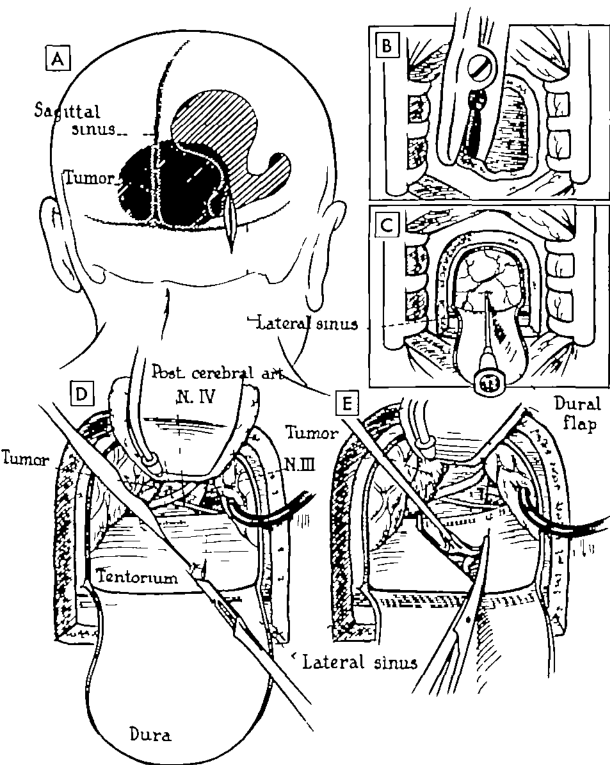
**B** One-inch trephine opening with the lower edge made square with rongeur to the edge of the lateral sinus.

**C** Type of dural incision in relation to the lateral sinus needle is inserted into the dilated lateral ventricle for drainage

**D** Occipital lobe elevated to the incisura with lighted retractor tentorium incised catheter inserted into the temporal horn through the inferior portion of the temporal occipital lobe.

**E** Wedge of tentorium removed for decompression of tumor which is wedged above and below the tentorium

*(Continued on Plate 63)*


A
B
C
D
E
Sagittal sinus
Tumor
Lateral sinus
Post. cerebral art.
N. IV
Tumor
Tumor
N. III
Dural flap
Tentorium
Lateral sinus
Dura

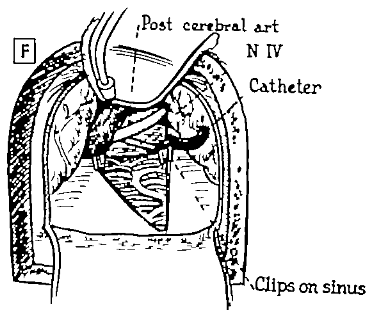
F Biopsy of tumor

If the tumor is composed of degenerated tissue it can be readily aspirated. If incomplete extirpation is made, it is necessary to carry out a modified Torkildsen by inserting the distal end of the catheter into the cisterna pontis.

G Site of tumor in relation to the ventricles location of the modified Torkildsen tube.

This tube is of no value if the tumor is of sufficient magnitude to tamponade the lateral cisterns as well as the cisterna pontis. If sufficient space is available for the fluid to flow through the cisterna pontis to the interpeduncular cistern then the tube should be used

X ray treatment is instituted to the pinealoma as soon as the condition of the patient warrants it.


F
Post cerebral art
N IV
Catheter
Clips on sinus

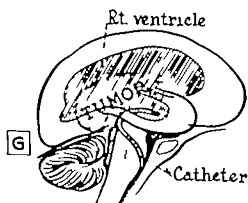

Rt. ventricle
TUMOR
G
Catheter

Plate 63

A The patient is placed in a sitting position with head slightly flexed incision is shown.

The lateral inferior limb extends approximately 2 cm. below the tip of the mastoid the medial limb ends 2 to 3 cm below the level of the inion.

B The muscle is detached from bone with the electrosurgical knife.

C The mastoid foramen is occluded airtight with wax immediately upon dividing the emissary vein

With the patient in the upright position, it is important that all possible venous spaces be occluded to prevent air embolus. Air may be aspirated into the sinuses through several avenues mastoid foramen emissary vein, larger open veins in the muscle flap, opening in the transverse sinus and the diploic vein in the porous edges of bone.

Multiple burr openings with electric drill simplify bone removal and permit the opening to be made closer to the mastoid cells and transverse sinus. The burr opening above the lateral sinus allows the lateral ventricle to be decompressed by ventricular drainage if obstructive hydrocephalus is present.

*(Continued on Plates 65 to 69)*

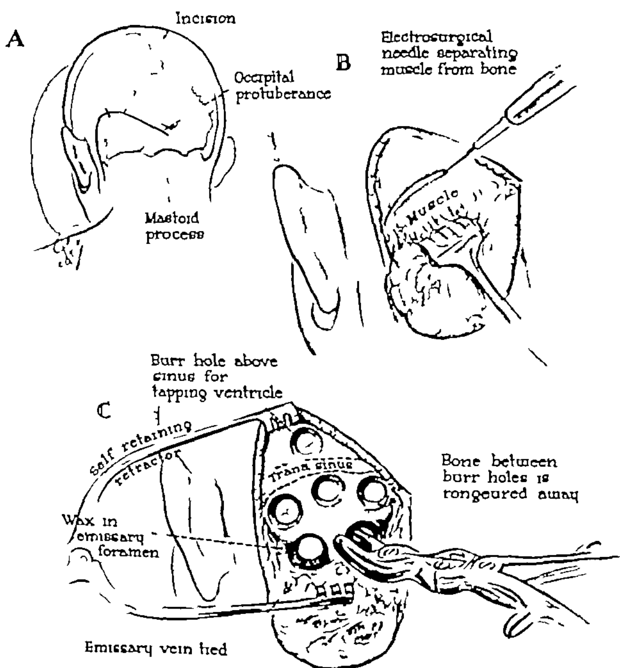

A
Incision
Occipital protuberance
Mastoid process
B
Electrosurgical needle separating muscle from bone
Muscle
C
Burr hole above sinus for tapping ventricle
Self retaining retractor
Trans sinus
Bone between burr holes is rongeured away
Wax in emissary foramen
Emissary vein tied

Plate 64

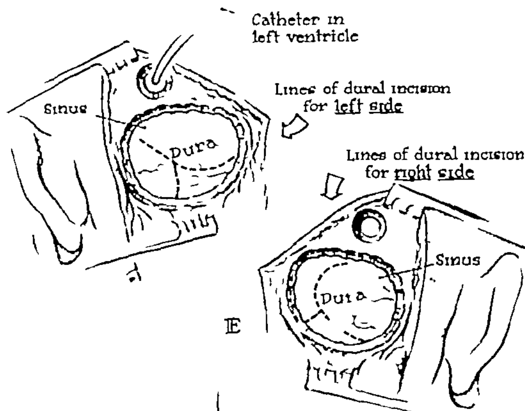
D Ventricular catheter in lateral ventricle. Type of dural incision for a left sided exposure

E Dural incision for right-sided exposure.

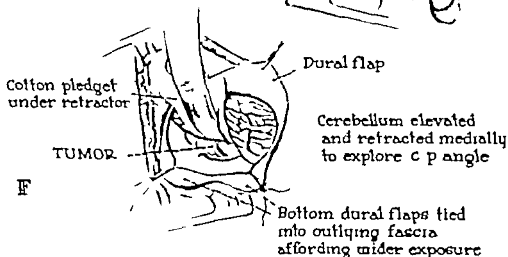
The reason for variation in the incision is simplification of the dural closure at completion of the operation if the surgeon is right-handed.

F Dural edges sutured to muscle and fascia for better exposure. The cerebellopontine angle is explored by elevation of the lateral inferior margin of the cerebellar hemisphere. A small arachnoid cyst containing xanthochromic fluid frequently overlies the inferior margin of an acoustic neuroma and is opened

*(Continued on Plates 66 to 69)*



D
Catheter in left ventricle
Lines of dural incision for left side
Sinus
Dura
Lines of dural incision for right side
Sinus
Dura
E

Dural flap
Cotton pledget under retractor
Cerebellum elevated and retracted medially to explore c p angle
TUMOR
F
Bottom dural flaps tied into outlying fascia affording wider exposure


Plate 65

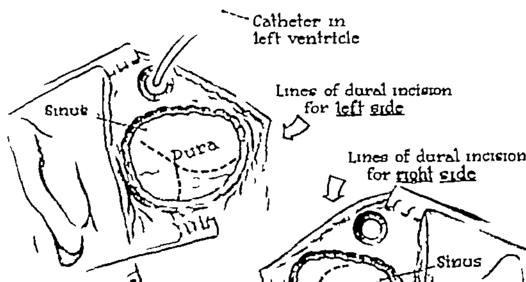
**D** Ventricular catheter in lateral ventricle. Type of dural incision for a left sided exposure.

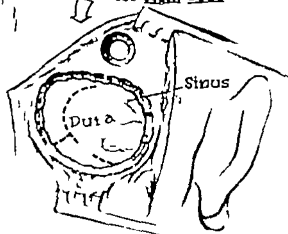
**E** Dural incision for right-sided exposure.

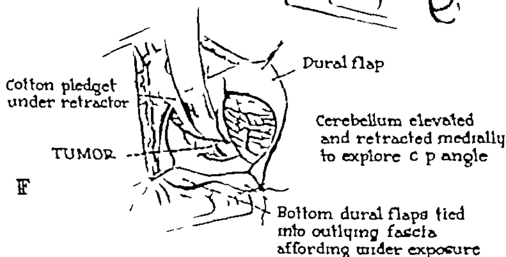
The reason for variation in the incision is simplification of the dural closure at completion of the operation if the surgeon is right-handed.

**F** Dural edges sutured to muscle and fascia for better exposure. The cerebellopontine angle is explored by elevation of the lateral inferior margin of the cerebellar hemisphere. A small arachnoid cyst containing xanthochromic fluid frequently overlies the inferior margin of an acoustic neuroma and is opened

(*Continued on Plates 66 to 69*)


D
Catheter in
left ventricle
Sinus
Dura
Lines of dural incision
for left side


Lines of dural incision
for right side
Sinus
Dura
E


Dural flap
Cotton pledget
under retractor
Cerebellum elevated
and retracted medially
to explore c p angle
TUMOR
F
Bottom dural flaps tied
into outlying fascia
affording wider exposure

**G** Cortical vessels occluded at line of incision

**H** Outline of area to be resected.

**I** Removal carried out with electrosurgical suction unit.

**J** After excision of the lateral portion, the cerebellar hemisphere is elevated medially and cephalad

**K** The lower group of cranial nerves, the ninth tenth and eleventh are freed from the inferior medial edge of the tumor and kept protected with a moist cotton pledget.

With the use of urea given intravenously at the start of the operation, excision of the lateral margin of the cerebellar hemisphere is usually unnecessary

*(Continued on Plates 67 to 69)*

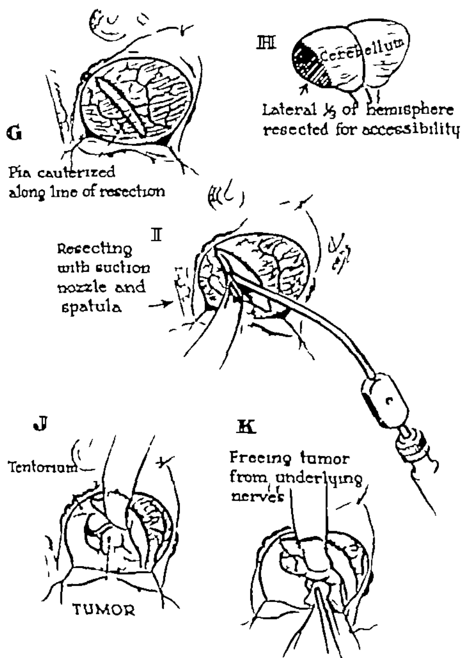

G
Pia cauterized
along line of resection
H
Cerebellum
Lateral ⅓ of hemisphere
resected for accessibility
I
Resecting
with suction
nozzle and
spatula
J
Tentorium
TUMOR
K
Freeing tumor
from underlying
nerves

Plate 66

L Arterial vessels over the inferior portion of tumor edge are occluded with the electrosurgical unit a core of tissue is removed with either the electrosurgical knife or the ordinary scalpel.

M Intracapsular removal is performed with a pituitary scoop.

N Further removal by glass suction care being taken not to injure or penetrate the capsule.

O The petrosal vein, as it lies over the superior margin of the capsule, may then be coagulated divided and brushed from the tumor capsule.

In this manner annoying bleeding which may occur if the capsule and vein are retracted from the petrosal sinus can be prevented. The tumor capsule is then elevated from the caudad medial aspect. If adherent to the capsule, the lower cranial nerves must be carefully separated The posterior inferior cerebellar arterial branch is divided on the capsule after it has been coagulated or divided between clips occlusion of the major vessels must be prevented since this always results in future disability

Dissection is carried out by placing cotton pledgets on the tumor capsule, and gently brushing the capsule from the cerebellar tissue and pons as the capsule is being retracted downward and the cerebellar hemisphere upward and medially Great care must be exercised when encountering the site of emergence of the eighth cranial nerve from the pons it is in this area where the seventh cranial nerve may be injured. Usually the seventh nerve is placed anteriorly to the tumor however it may be displaced cephalad and on rare occasions it may be in the caudad position

As soon as the seventh nerve has been identified, it is separated from the capsule medially and toward the porus acusticus. A cotton pledget is placed over it and dissection carried out from the pontine angle. The fifth cranial nerve is usually distorted to its greatest degree at its junction with the pons. It is also in this region that the plexus of veins is present and must be coagulated on the tumor capsule, divided, and then gently brushed away from the capsule, rather than attempting to coagulate them on the side of the pons. In rare instances the sixth cranial nerve is firmly adherent to the tumor but it is usually displaced medially For this reason, care must also be instituted at the time the capsule is freed from its most medial anterior portion.

P *After the bulk of the tumor has been mobilized it is wise to remove the greater* bulk, leaving the attachment in the porus acusticus

*(Continued on Plates 68 and 69)*

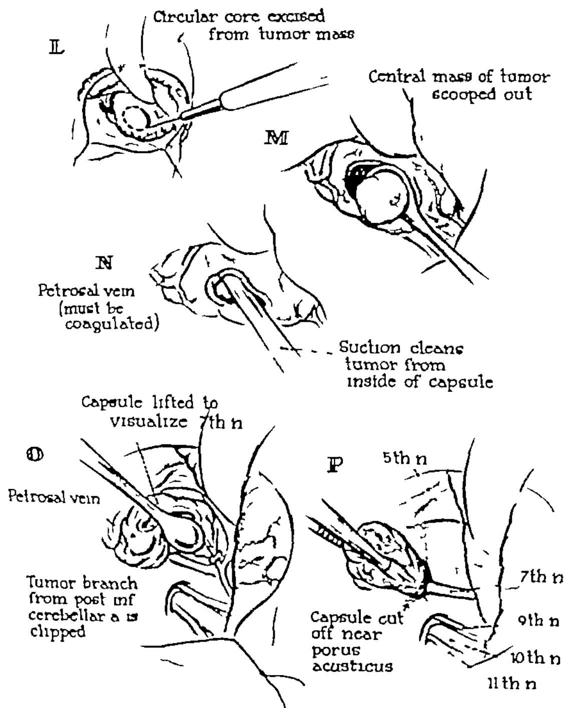

L
Circular core excised from tumor mass
Central mass of tumor scooped out
M
N
Petrosal vein (must be coagulated)
Suction cleans tumor from inside of capsule
Capsule lifted to visualize 7th n
O
Petrosal vein
Tumor branch from post inf cerebellar a is clipped
P
5th n
7th n
Capsule cut off near porus acusticus
9th n
10th n
11th n

Plate 67

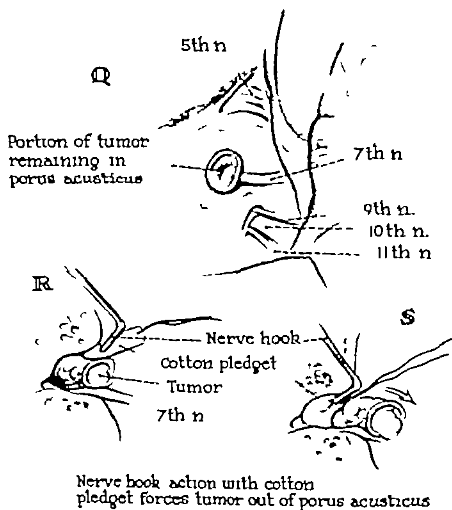
**Q** Portion of tumor remaining in the porus acusticus.

**R** Firm, rolled, small cotton pledget inserted into the porus acusticus and firmly pushed into the canal by means of a right-angled nerve hook.

**S** This displaces the tumor and forces it out of the porus acusticus in most instances

If the tumor is inaccessible, it may be necessary to remove the roof of the porus acusticus with mallet and chisel, in order to remove the remaining tissue. Excessive coagulation in the cephalad portion of the porus acusticus is not justifiable, since a slough may occur through the eustachian tube at a later date.

*(Continued on Plate 69)*




Nerve hook action with cotton pledget forces tumor out of porus acusticus

**T** Rubber catheters allowed to remain *in situ* for drainage.

**U** Dural closure.

**V** Closure of scalp with either two layers of interrupted black silk sutures or one layer of interrupted stainless steel wire.

**W** Ventricular and cavity drainage.

After the dressing has been applied the patient is placed in bed in a semisitting position.

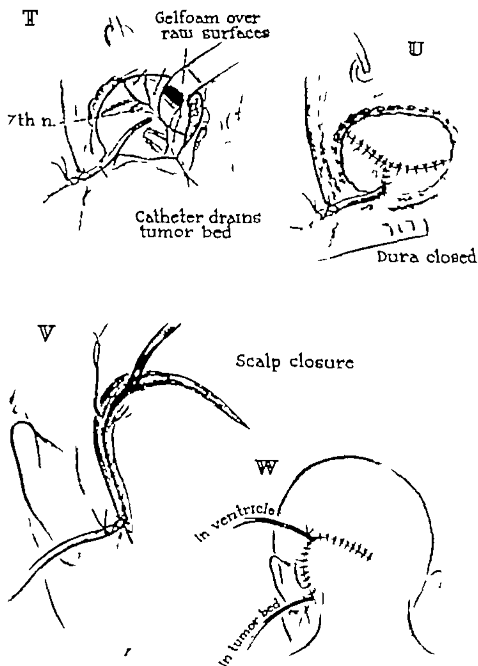

T
Gelfoam over
raw surfaces
7th n.
Catheter drains
tumor bed
U
Dura closed
V
Scalp closure
W
In ventricle
In tumor bed

Plate 69

**A** Cerebellar hemispheres exposed The right cerebellar hemisphere is enlarged the tonsil in the foramen magnum is depressed more than the left tonsil The solid portion of the tumor is located at the level of the transverse sinus.

**B** Cystic portion of the tumor drained through a ventricular needle.

This allows the right cerebellar hemisphere to fall away from the tentorium, permitting excision of the tumor over its most dependent portion beneath the tentorium. The solid portion of the tumor is surrounded with the electrosurgical unit, sealing off the entering blood vessels.

**C** Solid nodule excised The solid portion is sometimes located well beneath the tentorium.

If the fluid is aspirated initially only the superior portion of the cerebellar hemisphere needs to be removed It is always important to incise the most attenuated portion of the cerebellum and attack the tumor through that area.

**D** Tumor excised cavity

Catheter is inserted into the cavity The dura is left widely open and the usual scalp closure is *made with either a layer of interrupted black silk sutures or a single layer of end-on mattress* stainless steel wire sutures

*(Continued on Plates 71 and 72)*

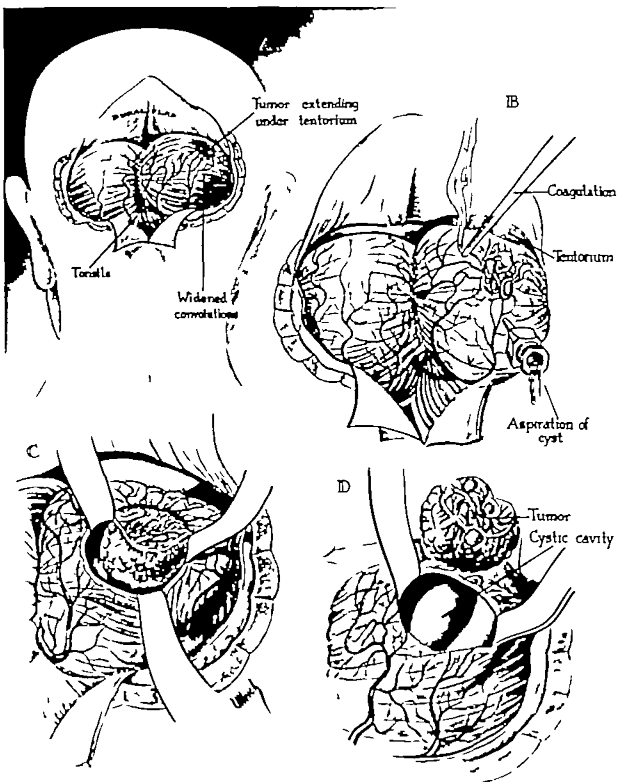

A
Tumor extending
under tentorium
Tonsils
Widened
convolutions
B
Coagulation
Tentorium
Aspiration of
cyst
C
D
Tumor
Cystic cavity

Plate 70

*Hemangioma with Small Mural Nodule*

Widening of the convolutions of the left cerebellar hemisphere the left tonsil is more deeply depressed into the foramen magnum than the right tonsil.

The thinnest portion of the cortex overlying the tumor is incised and opened. It is important to inspect carefully all cystic cavities for a mural nodule. The nodule may be so small that it can be found only by the most minute examination of the cyst wall. This is especially true if there is no *external manifestation of the tumor over the cortex.*

The mural nodule is excised. It is not necessary to excise a large area of normal tissue. Merely removing the small tumor is sufficient.

*(Continued on Plate 72)*

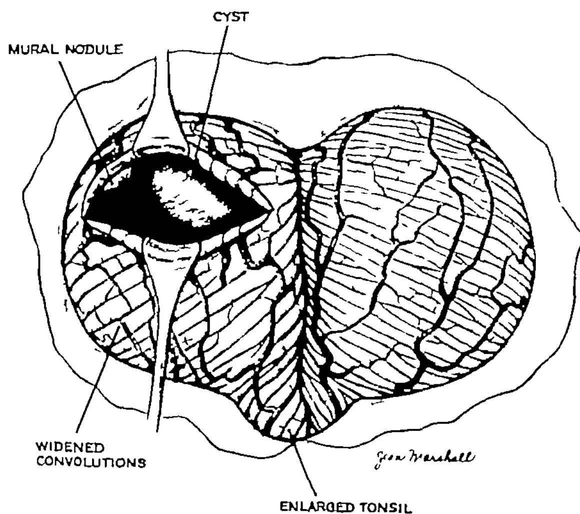



Plate 71

# CYSTIC HEMANGIOMA OF THE CEREBELLUM

*Hemangioma of Vermis*

Illustration of a cystic hemangioma in the midline, with enlargement of the vessels surrounding it, and the mural nodule. The vermis has been split in the midline.

The mural nodule is removed in the usual manner



Plate 72

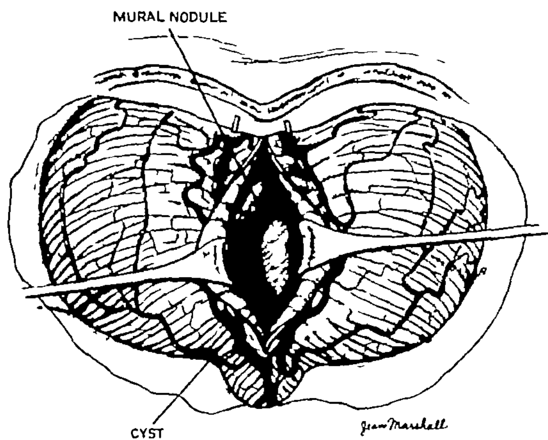



Plate 72

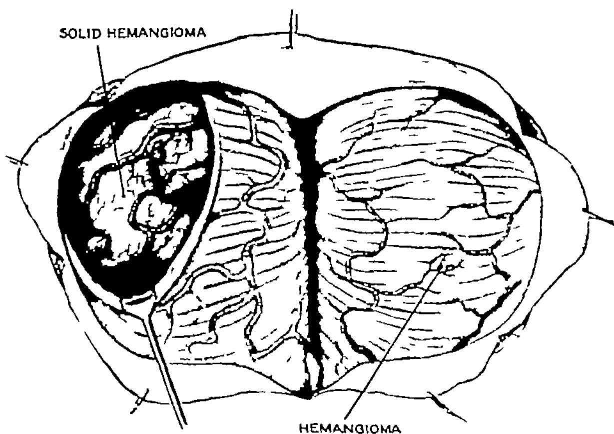



Plate 73

# ASTROCYTOMA OF THE LEFT CEREBELLAR TONSIL

Astrocytomas of the cerebellum may be either cystic or solid. The cystic type with a mural nodule is extirpated in a manner similar to that used in the operation for Cystic Hemangioma of the Cerebellum (Plates 71 and 72)

Astrocytoma involving the tonsil of the left hemisphere and displacing the medulla.

The tonsil is gently elevated and cotton pledgets are inserted over the lower group of cranial nerves. Branches of the posterior inferior cerebellar artery are exposed and divided leaving the main trunk of the artery intact. The tumor should be extirpated completely unless it invades the floor of the fourth ventricle in this instance a thin shell of tumor is left intact.

The dura is left widely open following extirpation and the scalp is closed in the usual manner

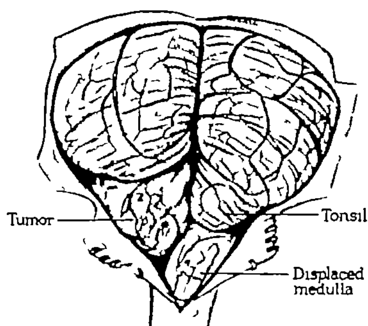



Plate 74

A Operative site type of incision and bone flap

B For adequate exposure, either the temporal lobe is elevated and the anterior portion of the hippocampal gyrus removed, or the inferior portion of the temporal lobe is excised.

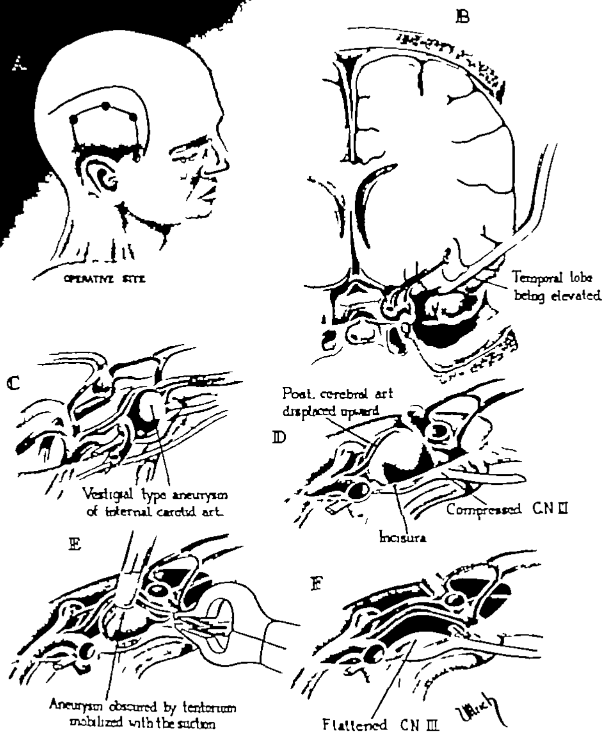
C Location of aneurysm displacing the posterior communicating artery and also compressing the third cranial nerve. The neck of the aneurysm however is easily accessible, and of such length that a clip may be applied.

D Aneurysm with the neck slightly submerged, making it impossible to apply a clip accurately

E If the neck cannot be exposed properly for application of clip, suction is applied to the aneurysm and the aneurysmal wall intentionally ruptured. This allows the aneurysm to enter the glass suction tube, providing adequate exposure of the neck of the aneurysm so that a clip may be accurately applied.

In this particular instance it is wise to occlude temporarily the internal carotid artery immediately beneath the optic nerve, obviating excessive bleeding at the time the clip is applied

F In most instances the aneurysm itself should not be excised after the clip has been applied. In this particular instance, the aneurysm was excised to demonstrate the marked flattening and depression in the third cranial nerve.


A
OPERATIVE SITE
B
Temporal lobe
being elevated
C
Vestigial type aneurysm
of internal carotid art.
Post. cerebral art
displaced upward
D
Compressed CN III
Incisura
E
F
Aneurysm obscured by tentorium
mobilized with the suction
Flattened CN III

Aneurysm of the middle cerebral artery trunk near the trifurcation.

**A** Type of incision and bone flap

**B** Cross section at the level of the aneurysm lying in the sylvian cleft. The temporal lobe, usually immediately in the vicinity of the aneurysm is gliotic. Arachnoidal adhesions protect the aneurysm

**C** Relative locations of aneurysms on the left and right sides.

**D** Arachnoidal adhesions are carefully allowed to remain attached to the aneurysm If an attempt is made to separate the adhesions from the aneurysms, rupture will usually occur The arachnoid is incised well away from the aneurysm, allowing muscle to completely surround the middle cerebral artery and the aneurysm.

**E** Muscle completely wrapped around the aneurysm and parent vessel.

*(Continued on Plate 77)*

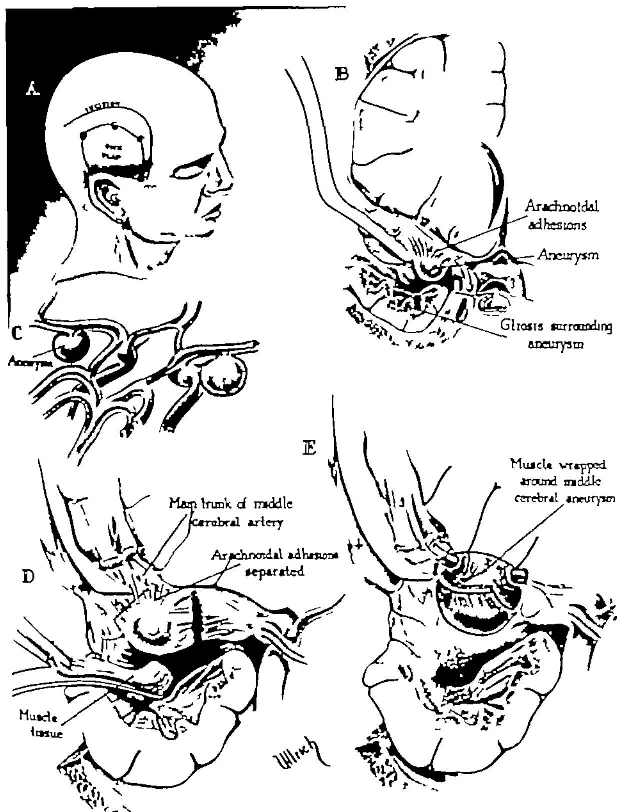

A
B
Arachnoidal adhesions
Aneurysm
Gliosis surrounding aneurysm
C
Aneurysm
D
Main trunk of middle cerebral artery
Arachnoidal adhesions separated
Muscle tissue
E
Muscle wrapped around middle cerebral aneurysm

Plate 76

# ANEURYSM OF THE MIDDLE CEREBRAL ARTERY

Saccular aneurysms of the middle cerebral artery associated with intracerebral hematoma.

F Line of incision over the greatly enlarged superior gyrus of the temporal lobe.

G Hematoma evacuated silver clip attached to the neck of the aneurysm.

H Relative positions of aneurysms.

I *In patients with a recent rupture of aneurysm with a large intracerebral hemorrhage in the* temporal lobe, aneurysm may rupture at the time of evacuation of the hematoma.

J Glass suction placed over the area of rupture. The fragmented portion of the aneurysm enters the glass suction tube a silver clip can then be placed at the base of the aneurysm in a dry field

Care must be taken to prevent occlusion of the parent vessel with the silver clip.

Aneurysms at the trifurcation may be treated in a similar manner If the aneurysm is located on the fronto-orbital or temporal branch of the trifurcation, it may either be excised between clips or simply tacked between clips. Great care must be exercised at all times to save the main trunk of the middle cerebral artery and its branch, the angular artery

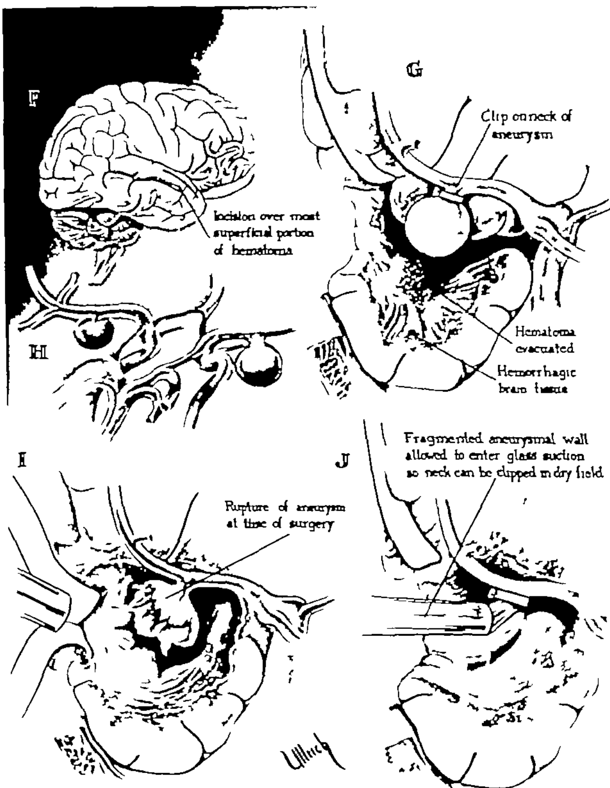

F
G
Clip on neck of aneurysm
Incision over most superficial portion of hematoma
H
Hematoma evacuated
Hemorrhagic brain tissue
I
J
Fragmented aneurysmal wall allowed to enter glass suction so neck can be clipped in dry field
Rupture of aneurysm at time of surgery

Plate 77

# ANEURYSMS OF THE BIFURCATION OF THE INTERNAL CAROTID MIDDLE AND ANTERIOR CEREBRAL ARTERIES

*Various types of aneurysms seen at the bifurcation of the internal carotid artery*

A The only type which lends itself to direct attack.

B

C Aneurysms treated by ligation of the internal carotid artery in the neck.

D

*(Continued on Plates 79 and 80)*

# ANEURYSMS OF THE BIFURCATION OF THE INTERNAL CAROTID MIDDLE AND ANTERIOR CEREBRAL ARTERIES

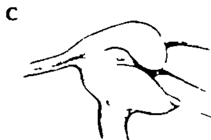
A



B



C



D



Plate 78

# ANEURYSMS OF THE BIFURCATION OF THE INTERNAL CAROTID MIDDLE AND ANTERIOR CEREBRAL ARTERIES

Illustrations of aneurysms of the middle cerebral artery

E Pedunculated type which can be readily occluded with a clip at the neck

F Aneurysms involving the fronto-orbital branch can be either excised between clips or simply trapped

G
H Types to be reinforced with complete muscle wrapping.
I

J Favorable type for clipping at neck.

(*Continued on Plate 80*)

# ANEURYSMS OF THE BIFURCATION OF THE INTERNAL CAROTID MIDDLE AND ANTERIOR CEREBRAL ARTERIES

E



F



G



H



I



J



Plate 79

# ANEURYSMS OF THE BIFURCATION OF THE INTERNAL CAROTID MIDDLE AND ANTERIOR CEREBRAL ARTERIES

Various types of aneurysms of the anterior cerebral artery group

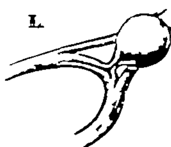
For surgical treatment, refer to Aneurysms of the Anterior Cerebral and Communicating Arteries (Plates 81 and 82)

# ANEURYSMS OF THE BIFURCATION OF THE INTERNAL CAROTID MIDDLE AND ANTERIOR CEREBRAL ARTERIES

K



L



M



N



O



P



Plate 80

# ANEURYSMS OF THE ANTERIOR CEREBRAL AND COMMUNICATING ARTERIES

**A** Operative approach

**B** Frontal lobe elevated, exposing aneurysms. If many adhesions are present between the arachnoid and aneurysm it may be necessary to remove a portion of the frontal lobe medially to obtain proper exposure.

**C** Aneurysm with a broad base involving the entire anterior communicating artery firmly adherent to both callosal branches of the anterior cerebral arteries.

**D** Aneurysm of the anterior communicating artery with many adhesions.

Both C and D should be completely wrapped with muscle including the callosal branches as well as the anterior cerebral branches. Adhesions are left intact to the chiasm, however in D

**E** Aneurysm that has an adequate neck clip should be applied

*(Continued on Plate 82)*

# ANEURYSMS OF THE ANTERIOR CEREBRAL AND COMMUNICATING ARTERIES

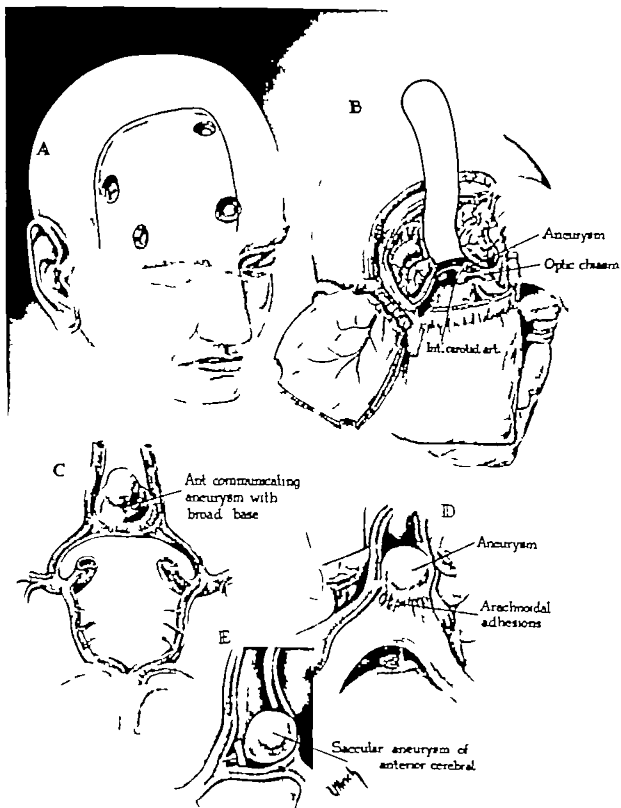



Plate 81

*Alternate Approach*

A Frontal lobe displaced laterally

B Cross section indicating the relation of structures to the aneurysm.

C In most instances the subfrontal convolutions immediately adjacent to the aneurysm are considerably enlarged because of hemorrhagic gliosis. That portion is resected for adequate exposure.

D Aneurysm mobilized and muscle wrapping begun.

E
F Completion of muscle wrapping.

To prevent future hemorrhage, it is important that no part of the aneurysm is left uncovered.

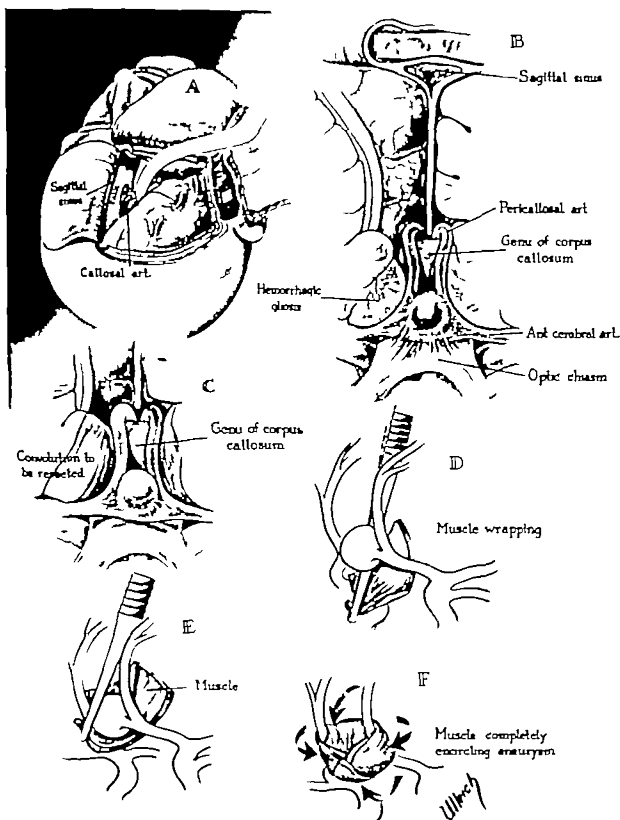

A
Sagittal sinus
Callosal art.
B
Sagittal sinus
Pericallosal art
Genu of corpus callosum
Hemorrhagic gliosis
Ant cerebral art.
Optic chiasm
C
Genu of corpus callosum
Convolution to be resected
D
Muscle wrapping
E
Muscle
F
Muscle completely encircling aneurysm
Ulrich

Plate 82

# ANEURYSMS OF THE POSTERIOR COMMUNICATING POSTERIOR CEREBRAL AND SUPERIOR CEREBELLAR ARTERIES AT THE HIATUS OF THE TENTORIUM

A Type of incision Bone flap is placed slightly farther posteriorly than it is for aneurysms arising from the posterior part of the internal carotid artery

B Posterior part of temporal lobe elevated to the incisura.

C *Location of aneurysm in the posterior communicating artery*

D *Only rarely is it necessary to incise the tentorial edge. Aneurysms of the posterior communi*cating artery are usually fusiform and can be readily isolated by placing a clip cephalad and caudad on the posterior communicating artery If the aneurysm points downward underneath the tentorial edge it may be necessary to incise the edge as demonstrated.

E F Aneurysms of the posterior cerebral and superior cerebellar arteries lying beneath the edge of the tentorium. Adequate room can be obtained by incising the tentorium as demonstrated and occluding the neck of the aneurysm with clips.

G *In most instances the aneurysm is left in situ after the neck has been occluded.*

To clarify the site of the aneurysm, however only the clips are shown here

# ANEURYSMS OF THE POSTERIOR COMMUNICATING POSTERIOR CEREBRAL AND SUPERIOR CEREBELLAR ARTERIES AT THE HIATUS OF THE TENTORIUM

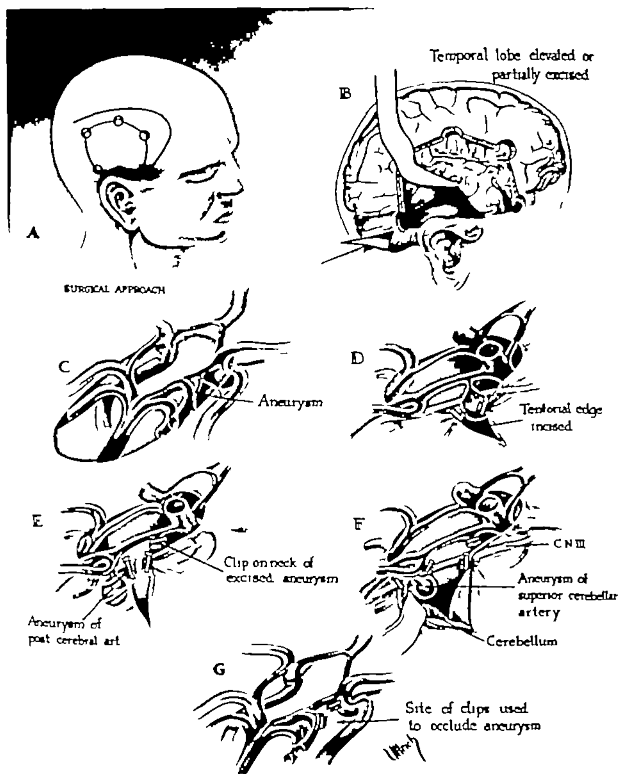



Plate 83

# ANEURYSMS OF THE POSTERIOR COMMUNICATING POSTERIOR CEREBRAL AND SUPERIOR CEREBELLAR ARTERIES AT THE HIATUS OF THE TENTORIUM

A Type of incision Bone flap is placed slightly farther posteriorly than it is for aneurysms arising from the posterior part of the internal carotid artery

B Posterior part of temporal lobe elevated to the incisura.

C Location of aneurysm in the posterior communicating artery

D Only rarely is it necessary to incise the tentorial edge. Aneurysms of the posterior communicating artery are usually fusiform and can be readily isolated by placing a clip cephalad and caudad on the posterior communicating artery If the aneurysm points downward underneath the tentorial edge, it may be necessary to incise the edge as demonstrated

E
F Aneurysms of the posterior cerebral and superior cerebellar arteries lying beneath the edge of the tentorium Adequate room can be obtained by incising the tentorium, as demonstrated and occluding the neck of the aneurysm with clips.

G In most instances the aneurysm is left *in situ* after the neck has been occluded

To clarify the site of the aneurysm however only the clips are shown here.

# ANEURYSMS OF THE POSTERIOR COMMUNICATING POSTERIOR CEREBRAL AND SUPERIOR CEREBELLAR ARTERIES AT THE HIATUS OF THE TENTORIUM

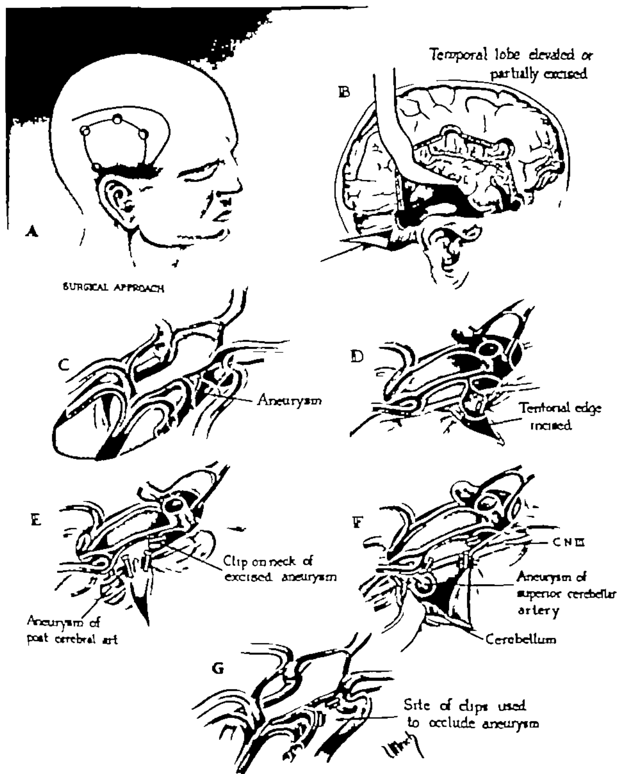



Plate 83

# ANEURYSM OF THE POSTERIOR-INFERIOR CEREBELLAR ARTERY

**A** Sitting position and line of incision.

For details of exposure, refer to Suboccipital Exploration (Cerebellar Exploration), Plates 142 to 147

**B** Left cerebellar tonsil distended with liquefied clot surrounding aneurysm

**C** Relation of aneurysm to posterior-inferior cerebellar artery

**D** Excision of hemorrhagic tonsillar tissue and evacuation of clot, exposing aneurysm which has been trapped between two silver clips

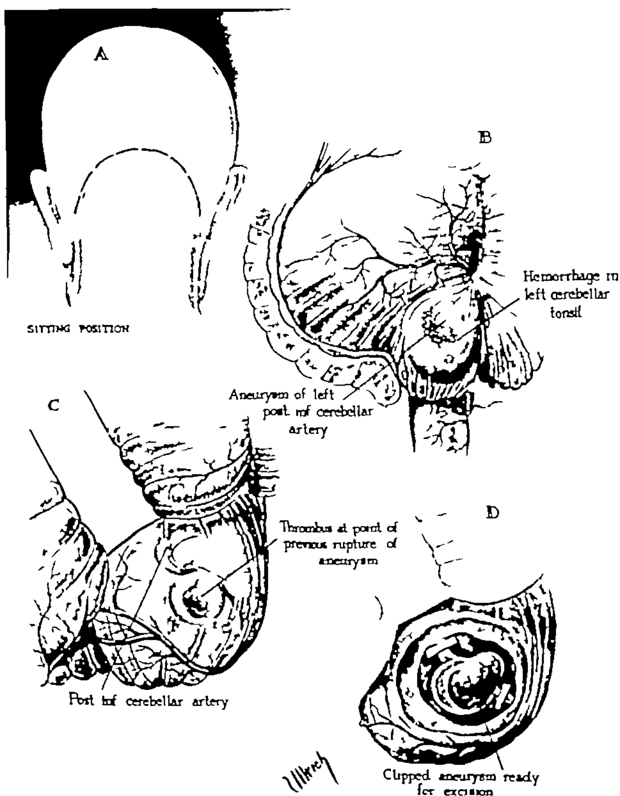

A
SITTING POSITION
B
Hemorrhage in left cerebellar tonsil
Aneurysm of left post. inf cerebellar artery
C
Thrombus at point of previous rupture of aneurysm
Post inf cerebellar artery
D
Clipped aneurysm ready for excision

Plate 84

# FUSIFORM ANEURYSM OF THE VERTEBRAL ARTERY

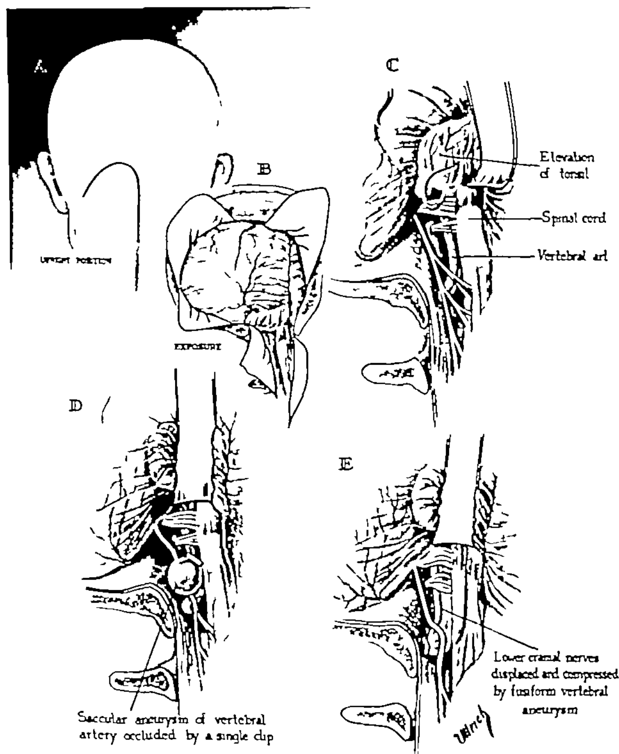
**A** Patient in the upright position type of incision

**B** Exposure of the left cerebellar hemisphere including the medial portion of the right. The roof of the foramen magnum and the first and second cervical laminae are removed

**C** The left cerebellar tonsil is elevated exposing the vertebral artery

**D** Saccular aneurysm of the vertebral artery is occluded at its neck with a silver clip.

**E** Fusiform aneurysmal dilatation of vertebral artery displacing medulla upper cervical cord and lower group of cranial nerves. Silver clip is applied at the point of entrance of the vertebral artery into the spinal canal


A
B
C
D
E
EXPOSURE
Elevation of tonsil
Spinal cord
Vertebral art
Saccular aneurysm of vertebral artery occluded by a single clip
Lower cranial nerves displaced and compressed by fusiform vertebral aneurysm

# COMBINED CERVICAL-CRANIAL PROCEDURE FOR INTRACRANIAL ANEURYSMS

Patients with large subclinoidal parasellar aneurysms may be treated by placing a clamp on the internal carotid artery in the neck If the patient can tolerate total occlusion of the internal carotid artery for a period of three or four days, a clip is placed on the internal carotid artery intracranially distal to the aneurysm.

Arteriograms will reveal whether a sufficient segment of internal carotid artery is present proximal to the bifurcation of the middle and anterior cerebral arteries.

The incision in the neck is reopened Immediately following closure of the craniotomy permanent sutures are placed above and below the segment of the internal carotid artery occluded by the clamp

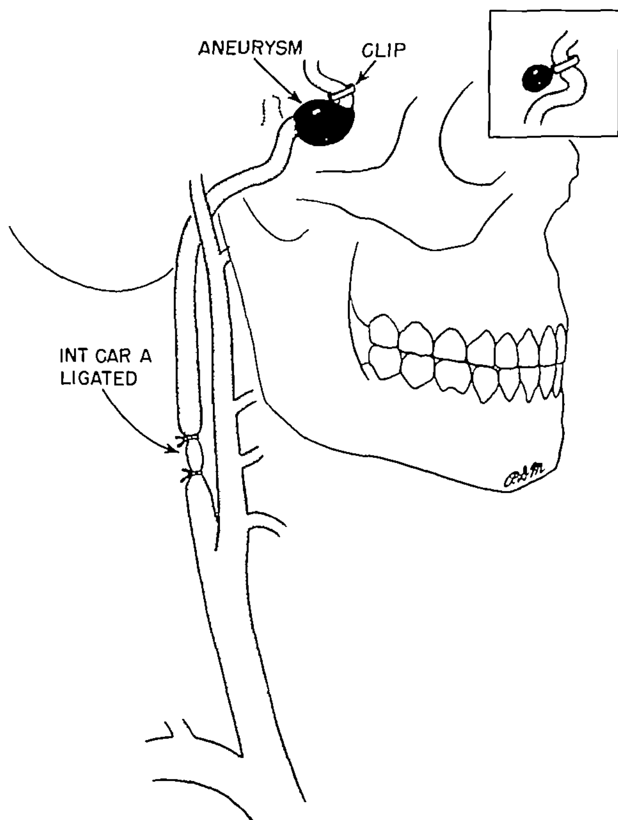
Schematic drawing, demonstrating the completed procedure.

*Inset* Vestigial type of aneurysm of the internal carotid artery below the bifurcation. The clip occludes the internal carotid artery at the neck of the aneurysm.

This procedure is possible only after determining that the patient can tolerate permanent occlusion of the internal carotid artery To verify this, a clamp is placed on the internal carotid artery in the neck and left *in situ* for three to four days. See Plate 153

In this particular instance the clamp may be removed immediately following the craniotomy It is not necessary to ligate the artery in the neck after removal of the clamp as would be essential with the trapping procedure.

# COMBINED CERVICAL-CRANIAL PROCEDURE FOR INTRACRANIAL ANEURYSMS



# ANGIOMA

A Location of malformation

B Pia-arachnoid coagulated with electrosurgical unit and incised

Care is taken not to enter the larger vessels away from the nidus of the tumor

C Location of nidus of the lesion

D Larger cortical vessels individually isolated away from the nidus and initially occluded by coagulation The vessels must also be divided between clips, despite apparent occlusion by the electrosurgical unit

Furthermore, the vessels are occasionally too large to be completely occluded by ordinary silver clips. This is obviated by constricting the vessels with coagulation before clips are applied. Usually blood vessel walls are so thin that permanent occlusion with *coagulation is impossible.*

E Compression of the mass of blood vessels against the falx and the individual ligation and division of arteries as they enter the mass.

It is important to leave draining vessels intact until the end of the procedure. Initial occlusion of these vessels causes rupture of the blood vessel tumor mass because of distention and engorgement.

F The entire mass has been separated from brain tissue and a stalk of the entering blood vessels may be ligated *en masse* either with a ligature of black silk or with a large clip

All bleeding points are carefully controlled.

*(Continued on Plate 89)*

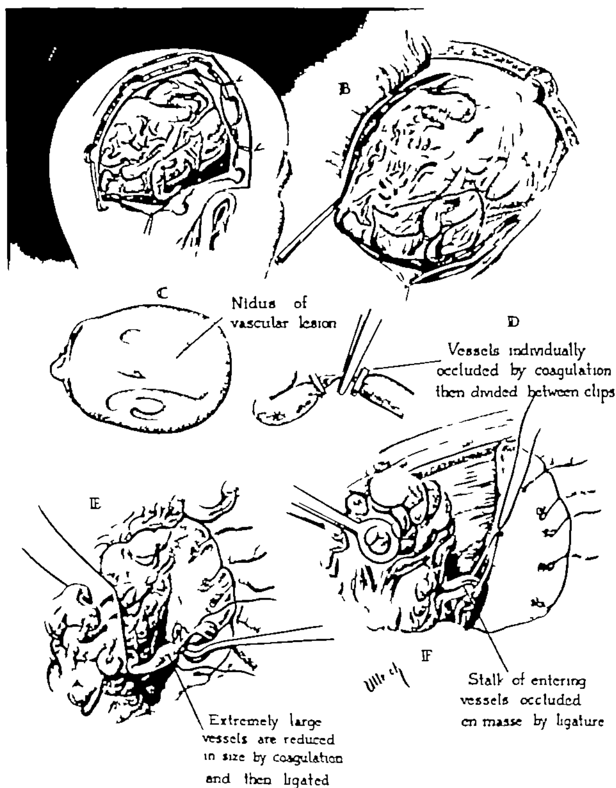
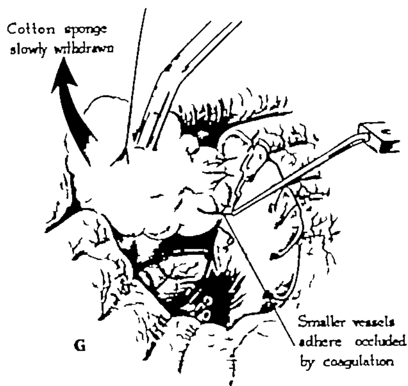

B
C
Nidus of vascular lesion
D
Vessels individually occluded by coagulation then divided between clips
E
F
Extremely large vessels are reduced in size by coagulation and then ligated
Stalk of entering vessels occluded en masse by ligature

Plate 88

G As soon as the mass of tumor has been removed a large cotton ball is placed in the cavity a large glass suction tip is applied to the cotton ball, and the latter gently elevated As this is being done the small branches of blood vessels will adhere to the cotton and may be sealed off with the electrosurgical unit coagulation being applied to the end of the vessel that is attached to the cotton rather than to the brain tissue. This allows the sealing off of the small vessels in a dry field

Removal of these tumors is greatly simplified by use of urea solution intravenously and by the production of mild hypotension during the removal in younger individuals. Hypothermia is not usually necessary


Cotton sponge
slowly withdrawn
Smaller vessels
adhere occluded
by coagulation
G

# CAROTICOCAVERNOUS SINUS FISTULA

**A** Anatomy of the cavernous sinus system White circles indicate positions of the rupture of the aneurysm into the cavernous sinus.

The direction of the arterial flow depends greatly upon the size of the aneurysm and the extent to which it has occluded the sinus, as well as upon the exact site of the rupture in the aneurysm—whether it has occurred anteriorly or posteriorly The presence or absence of pulsating exophthalmos is evident from the drawing.

**B** Cross section of normal structures in the cavernous sinus.

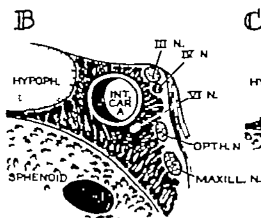
**C** Fusiform aneurysm, showing compression of the various nerves and obliteration of the greater part of the cavernous sinus.

Treatment consists of ligation of the internal carotid artery in the neck and intra cranially distal to the fistula. At times the exophthalmos persists after extracranial and intracranial ligation of the internal carotid artery this is usually the result of thrombosis of the superior and inferior ophthalmic veins intraorbitally The exophthalmos may be readily reduced by removing the roof of the orbit and excising the thrombosed veins.

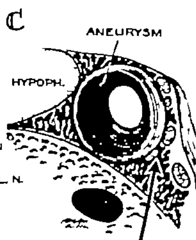
A

ANT. INTERCAVERNOUS SINUS
SPHENOPARIETAL SINUS
POST. CAV. SINUS
POINT OF FISTULA
CAV. SINUS
BASILAR SINUS

B




C



# ANTERIOR THIRD VENTRICLE TUMOR

**A** Patient placed in Fowler s position with head in vertical flexed position scalp incision osteoplastic bone flap location of cyst.

**B** A ventricular needle is inserted into the ventricle, either before or after dura is opened, to reduce intraventricular pressure. A transverse cortical incision is made in the anterior portion of the premotor cortex. The relation of the cyst to the foramen of Monro is shown.

**C** The ventricle is opened and explored with a lighted retractor on the anterior portion of the incision and a nonlighted malleable retractor on the posterior edge. The tumor can usually be seen immediately at the foramen of Monro

Fluid should be allowed to remain in the ventricle to prevent collapse of the hemisphere.

ANTERIOR THIRD VENTRICLE TUMOR

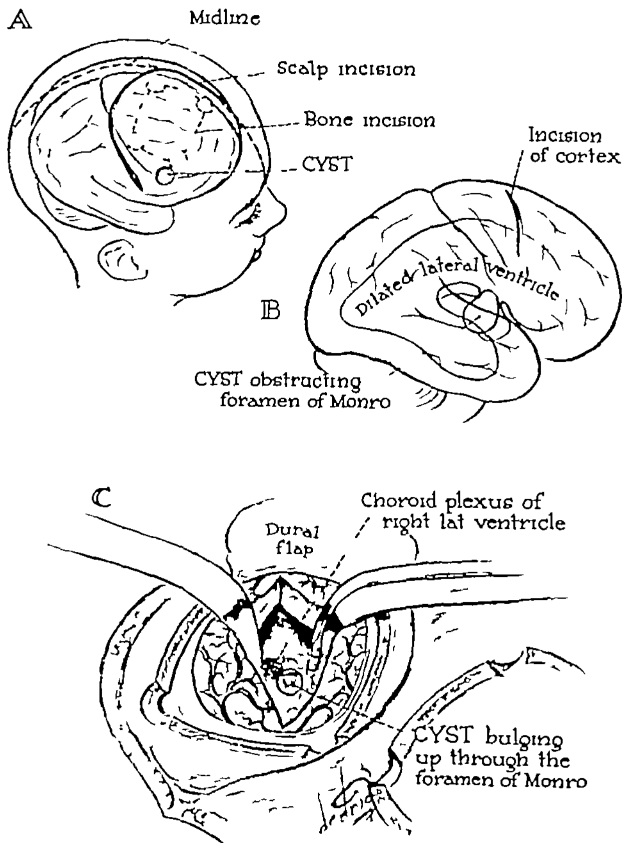



Plate 91

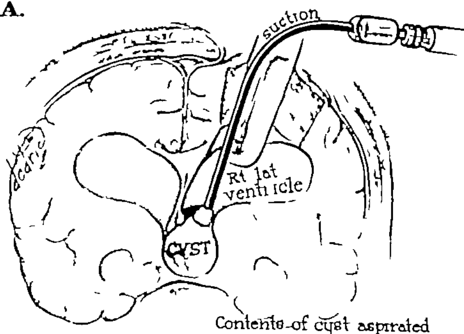
# COLLOID CYST OF THE THIRD VENTRICLE

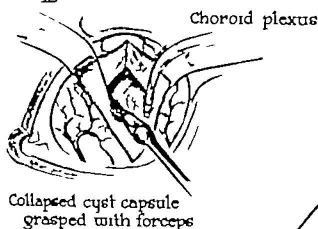
A The capsule of the cyst has been opened to allow aspiration of the gelatinous conte

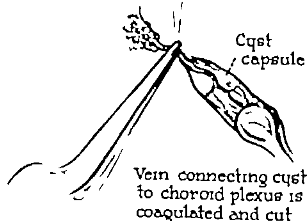
B Gentle traction on the empty cyst wall allows application of a silver clip to the chor
C plexus or occlusion of the choroidal vessels with the electrosurgical unit.

Care must be exercised to prevent the blades of the retractors from engaging the b
ganglia the ependyma may be lacerated resulting in subependymal bleeding.

*Inset* If cyst or tumor does not protrude through the foramen of Monro the sept
pellucidum is incised and the anterior third ventricle opened by continuing the incis
through the fornices. A catheter maintains ventricular drainage for twenty four ho


A.
suction
cicatrix
Rt lat ventricle
CYST
Contents of cyst aspirated


B
Choroid plexus
Collapsed cyst capsule grasped with forceps


C
Cyst capsule
Vein connecting cyst to choroid plexus is coagulated and cut

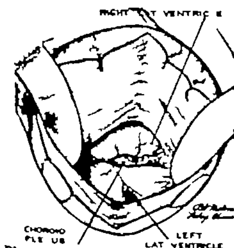

LEFT LAT VENTRICLE

Plate 92

*Alternate Method*

In patients with extremely large ventricles an alternate method of approach can be used the exploration is carried out through a trephine opening. Adequate room can be obtained in this manner

A Site of incision and trephine opening

B Trephine button removed dura opened cortical incision

The operation is completed in a manner similar to that shown in Anterior Third Ventricle Tumor and Colloid Cyst of the Third Ventricle (Plates 91 and 92)

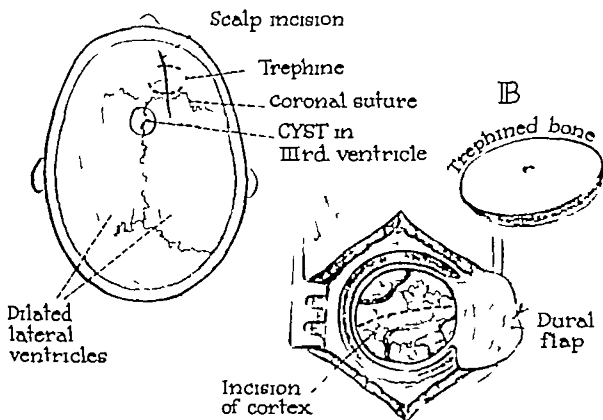

A.
Scalp incision
Trephine
coronal suture
CYST in
IIIrd. ventricle
Dilated
lateral
ventricles
B
Trephined bone
Dural
flap
Incision
of cortex

Plate 93

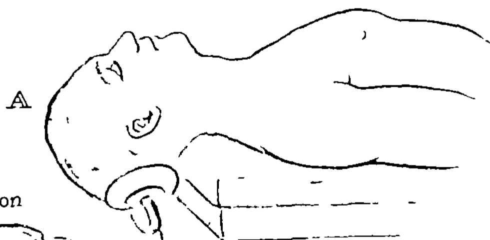
A Position of patient.

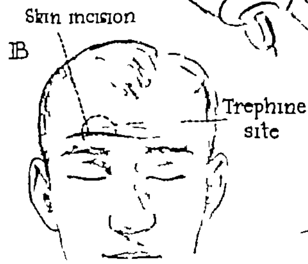
B Scalp incision made along wrinkle in forehead.

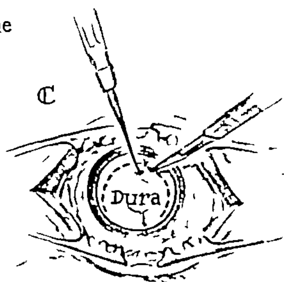
C One-inch trephine opening bone button removed dural flap opened.

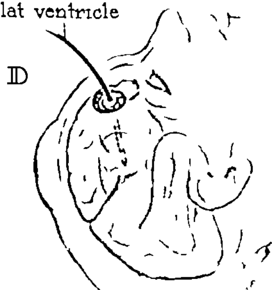
D Ventricular needle inserted into the anterior horn of the lateral ventricle catheter introduced through the track made by the ventricular needle, allowing the cerebrospinal fluid to be siphoned off

*(Continued on Plates 95 and 96)*






Trephined bone button removed and dura nicked for opening

E *Frontal lobe can be readily elevated to the optic chiasm to expose the distended anterior* third ventricle.

F Opening made in the lamina terminalis.

G Opening in the thin lamina enlarged.

H Metal suction tube inserted along the floor of the third ventricle and the inferior floor opened into the cisterna pontis.

*(Continued on Plate 96)*

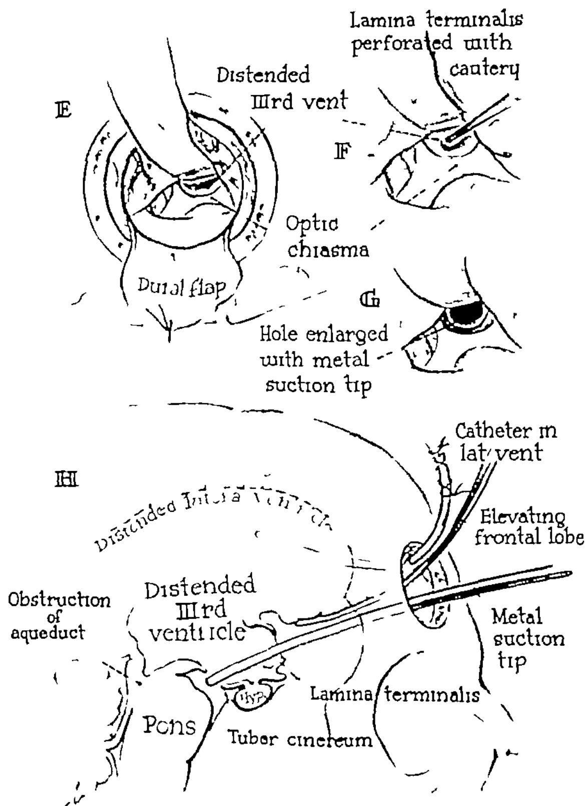

E
Distended
IIIrd vent
Lamina terminalis
perforated with
cautery
F
Optic
chiasma
Dural flap
G
Hole enlarged
with metal
suction tip
H
Catheter in
lat vent
Elevating
frontal lobe
Distended
IIIrd
ventricle
Obstruction
of
aqueduct
Metal
suction
tip
Lamina terminalis
Pons
Tuber cinereum

Plate 95

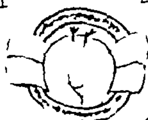
I Dura closed over Gelfoam

J Gelfoam is then placed over the line of incision in the dura and the bone flap tacked with two stainless steel wires.

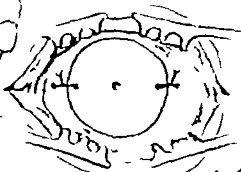
K Scalp closure.

L Dressing applied.

I

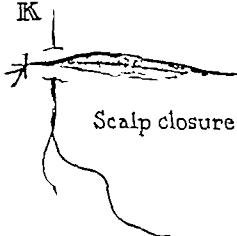


Dura closed over gelfoam
and bone-button wired in place

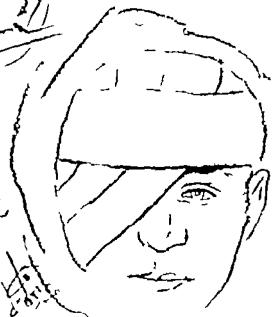


J

K




L

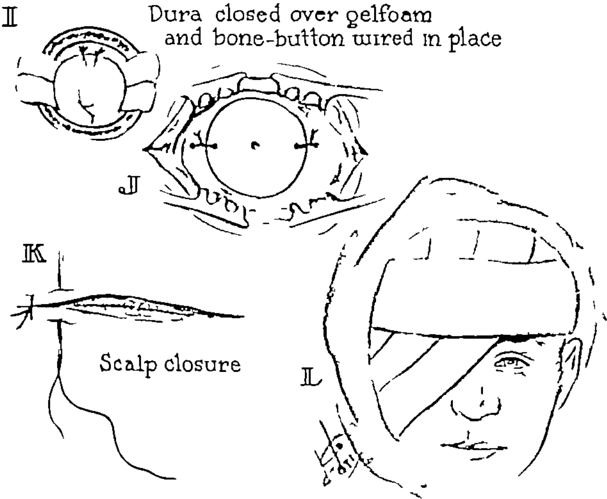


**I** Dura closed over Gelfoam.

**J** Gelfoam is then placed over the line of incision in the dura and the bone flap tacked with two stainless steel wires.

**K** Scalp closure.

**L** Dressing applied


I
Dura closed over gelfoam
and bone-button wired in place
J
K
Scalp closure
L

# OBSTRUCTIVE INTERNAL HYDROCEPHALUS TORKILDSEN PROCEDURE OF VENTRICULOCISTERNAL DRAINAGE

The Torkildsen procedure is of value in obstructive hydrocephalus, providing the cisterns around the pons are free, allowing the cerebrospinal fluid to circulate properly

**A** Patient in sitting position.

**B** Two incisions made in the scalp, one over the occipital region and the other just above the foramen magnum.

**C**
**D** Exposure of the lower occipital bone.

**E** Burr opening made over the midline.

*(Continued on Plates 98 99 and 100)*

# OBSTRUCTIVE INTERNAL HYDROCEPHALUS TORKILDSEN PROCEDURE OF VENTRICULOCISTERNAL DRAINAGE

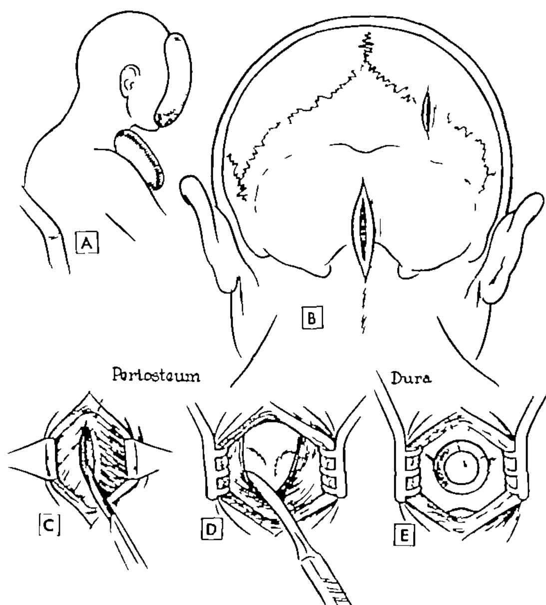



Plate 97

# OBSTRUCTIVE INTERNAL HYDROCEPHALUS TORKILDSEN PROCEDURE OF VENTRICULOCISTERNAL DRAINAGE

**F** Burr opening enlarged with a rongeur

**G** Incision made in the dura lateral to the occipital sinus

A burr opening is also made through the calvarium in the occipital region and the dura opened.

**H** Scalp undermined with a periosteal elevator between incisions.

(*Continued on Plates 99 and 100*)

# OBSTRUCTIVE INTERNAL HYDROCEPHALUS TORKILDSEN PROCEDURE OF VENTRICULOCISTERNAL DRAINAGE

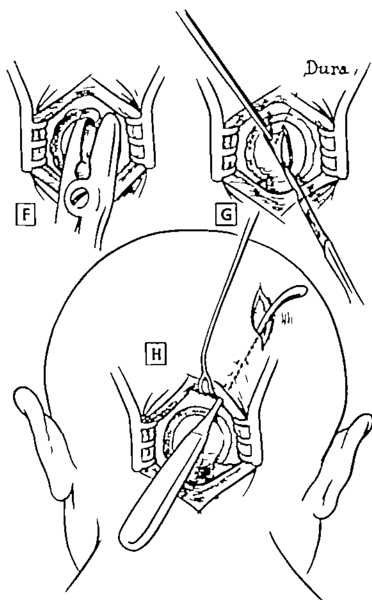



Plate 98

I Narrow groove made in the bone connecting the two burr openings.

J Catheter inserted underneath scalp and bone groove.

K Tip of catheter inserted through ventricular needle opening to the proper depth and sutured to dura.

L Distal end of catheter cut at proper length.

M End inserted into cisterna magna. ?

N Care is taken to be certain that the catheter is open.

(*Continued on Plate 100*)

# OBSTRUCTIVE INTERNAL HYDROCEPHALUS TORKILDSEN PROCEDURE OF VENTRICULOCISTERNAL DRAINAGE

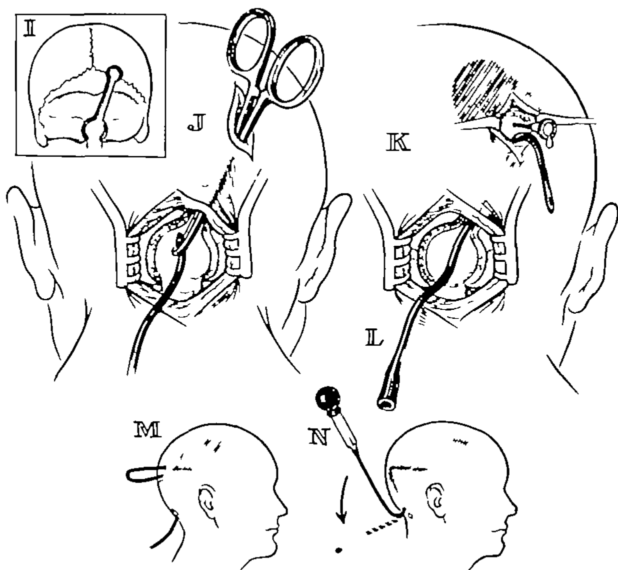



Plate 99

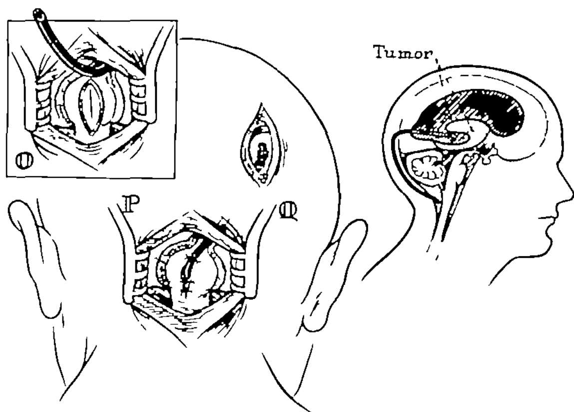
**O** Catheter cut at right angle

**P** Cut end inserted into the cisterna magna. The dura is closed and the catheter end sutured to the dural edges.

**Q** Schematic drawing of site of catheter

As this shows, adequate space must be present in the cisterna pontis to allow fluid from the ventricle to recirculate over the cerebral hemispheres.

# OBSTRUCTIVE INTERNAL HYDROCEPHALUS TORKILDSEN PROCEDURE OF VENTRICULOCISTERNAL DRAINAGE



# HYDROCEPHALUS VENTRICULOATRIAL SHUNT WITH HOLTER VALVE

A Sites of incision and location of the Holter valve.

Before surgery x ray films of the chest are taken so that proper measurements can be made from the clavicle to the atrium. The distance from the clavicle to the lower end of the valve can then be measured to obtain the approximate length necessary for the tubing.

Dilute solution of heparin is kept in the tubing at the time of its insertion to prevent clotting and also to prevent air from entering the atrium. The cephalad end of the tubing is kept closed at all times until it is attached to the valve An x ray film is then taken to determine if the end of the tube is in the proper position in the atrium. The valve should be milked just before the lower tubing is attached, to ascertain that the mechanism is working properly

Care should be taken that a bloodless ventricular tap has been made.

If ventriculography has been performed just before the atrioventricular shunt is instituted, most of the air can be readily removed by inserting physiological saline fluid into the ventricle and allowing the air to escape.

Following surgery the head should be kept toward the side of the shunt to prevent air that might not have escaped following ventriculography from entering the valve. In other words, the head should be kept in the proper position to insure that the end of the ventricular tube is covered with fluid at all times.

*(Continued on Plate 102)*

# HYDROCEPHALUS VENTRICULOATRIAL SHUNT WITH HOLTER VALVE

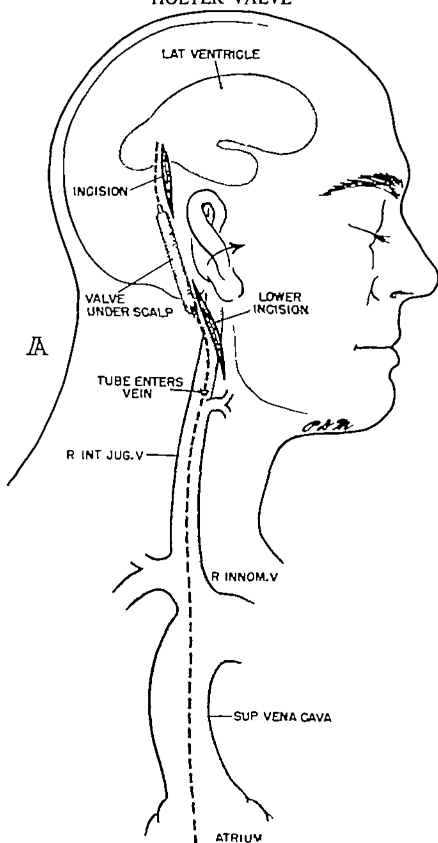



Plate 101

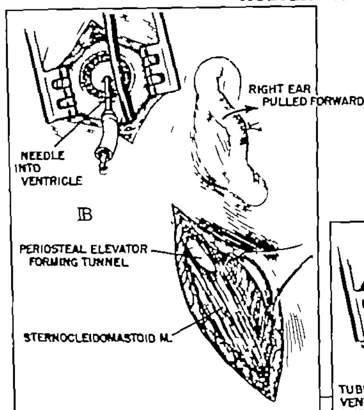
**B** Burr opening made in the region indicated in Plate 101 A. A periosteal elevator is used to elevate the scalp between the two incisions to allow insertion of the Holter valve.

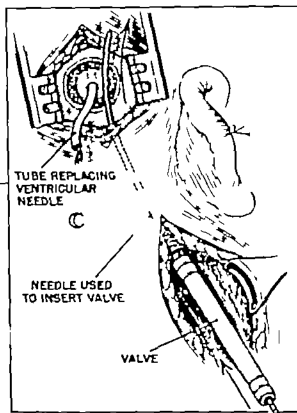
**C** A director attached to the Holter valve is inserted through the tunnel made under the scalp tissue over the mastoid.

**D** Ventricular tube attached to the end of the valve. A small opening is made into the jugular vein or the common facial vein. Polyethylene tubing treated with radiopaque substance is inserted through the opening. A thin wire adapter has been inserted through the tubing to give it stability leaving approximately 1 cm. of tubing extending beyond the tip of the wire guide.([illegible])

This facilitates guiding the tubing on a direct course into the atrium.

# HYDROCEPHALUS VENTRICULOATRIAL SHUNT WITH HOLTER VALVE



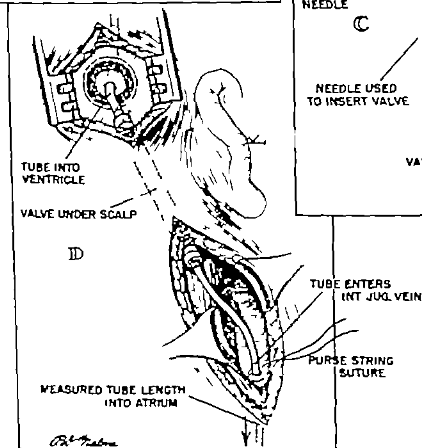




Plate 102

# Part I HEAD *(Concluded)*

## *Section 4* OTHER PROCEDURES INVOLVING THE HEAD

# Part I HEAD *(Concluded)*

## *Section 4* OTHER PROCEDURES INVOLVING THE HEAD

# CRANIOTOMY OPENING OSTEOPLASTIC FLAP

*Preoperative Measures*

In all major craniotomies the scalp is prepared by shaving immediately before the operation is begun. Preparation is not carried out the evening before surgery because patients are usually annoyed by having their heads clipped and shaved furthermore, the chance of contamination is lower if soap is used generously when the head is shaved immediately preceding the formal preparation of the scalp

While under general intratracheal anesthesia, the patient is placed in the proper position the position depends entirely on the location of the incision to be made. Intravenous fluids are given through an accessible vein in the lower extremity To prevent postoperative neck pain excessive rotation of the neck while the patient is under anesthesia should be carefully avoided. No pressure should be exerted over the major vessels of the neck. Compression of the jugular veins, from either the drapes or adhesive tape used to keep the intratracheal tube in position, may well increase engorgement of the cerebral veins.

In the supratentorial craniotomy the patient is placed in exaggerated Fowler's position with the head well above the heart level reducing the intracranial venous pressure.

*Operative Procedure*

A Position of the patient s head for temporal craniotomy

The head is placed on an adjustable head rest and a sandbag or rolled blanket is placed *under one shoulder to release the tension on the neck muscles.*

B Scalp prepared by thorough washing with soap

Soap is then removed with an alcohol preparation followed by application of colored tincture of Zephiran. Sterile gutta percha is placed over eyes.

C Scalp incision for temporal craniotomy outlined

Towels moistened in aqueous Zephiran solution are applied and sutured to the scalp with silk at strategic points. Moistened towels tend to stay in position better than the dry Formal draping of the patient is then completed

D *Assistants place the fingers of each hand above and below the line of incision* The surgeon places his thumb over the superficial temporal artery as indicated.

Note that the palmar surfaces of the fingers are used Assistants are inclined to use the very tips of the fingers, assuming they can exert more pressure in this way

The incision is made to the surface of the fascia over the temporal muscle and is continued beyond the muscle to the calvarium proper Hemostats are applied to the galea as indicated with the curved hemostats on the fixed edge of the scalp and the straight hemostats on the flap side of the scalp incision

*(Continued on Plates 104 to 108)*

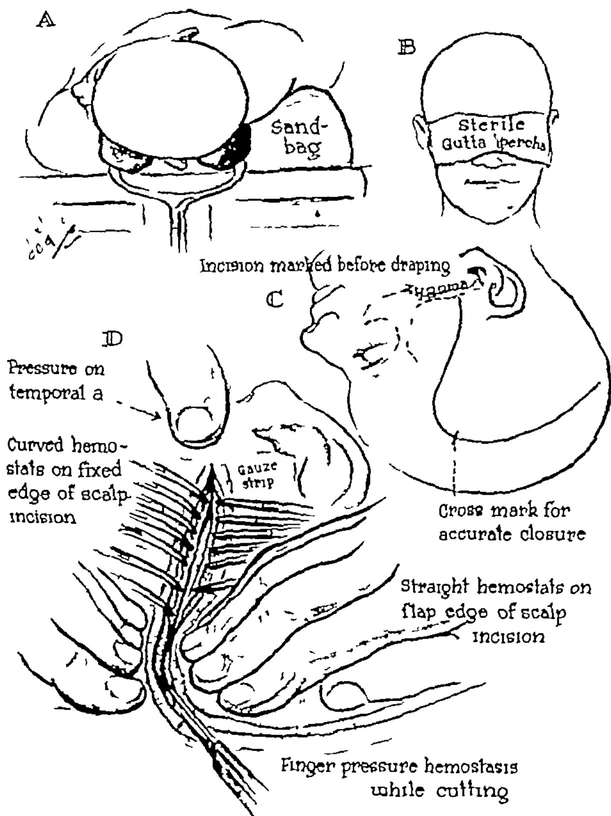

A
Sand-
bag
B
Sterile
Gutta percha
Incision marked before draping
C
Zygoma
D
Pressure on
temporal a
Curved hemo-
stats on fixed
edge of scalp
incision
Gauze
strip
Cross mark for
accurate closure
Straight hemostats on
flap edge of scalp
incision
Finger pressure hemostasis
while cutting

Plate 103

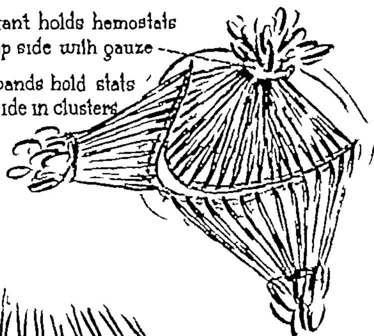
**E** Hemostats on the flap side are retained with a sponge held by an assistant

**F** Periosteal elevator used to separate the galea and periosteum from the bone.

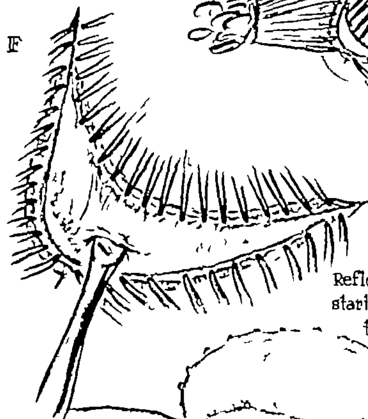
**G** As the scalp edge is freed, it can be readily reflected from the temporal fascia.

*(Continued on Plates 105 to 108)*

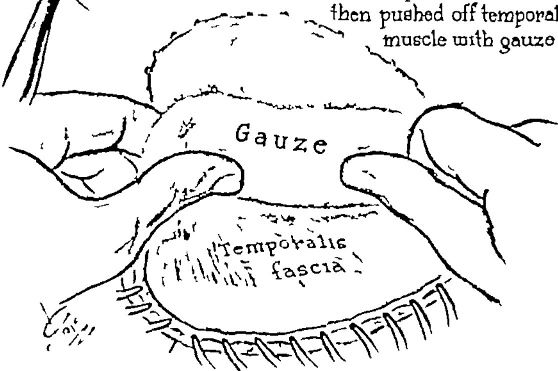
E


Assistant holds hemostats
on flap side with gauze
Rubber bands hold stats
on fixed side in clusters

F


Reflection of scalp flap is
started with periosteal elevator
then pushed off temporalis
muscle with gauze

G


Gauze
Temporalis
fascia

H Reflected portion of the scalp can be further immobilized by sharp dissection

I Gauze roll inserted beneath the scalp flap

J Scalp kept in position with self retaining retractors. Gutta-percha is placed over the raw surface of the scalp flap before the retractors are inserted. Bleeding points are controlled to a great degree in this manner

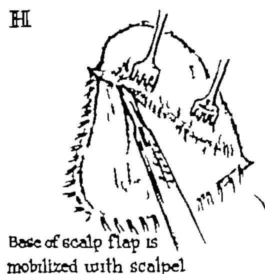
If gauze is used to protect the scalp flap bleeding points occur after it is removed This does not occur with gutta-percha or rubber tissue.

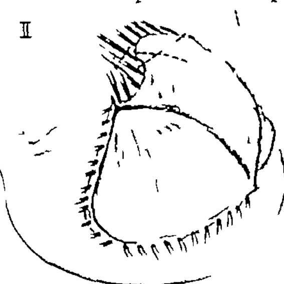
A small incision is made in the temporal muscle with a scalpel.

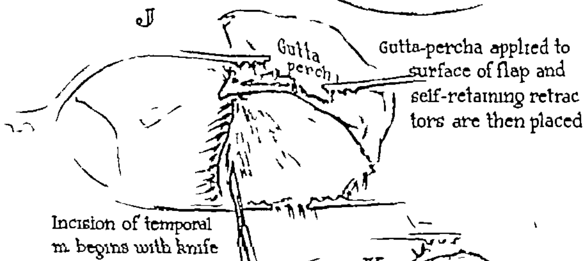
K Periosteal elevator inserted over the bone and beneath the muscle muscle elevated and incision completed with scissors.

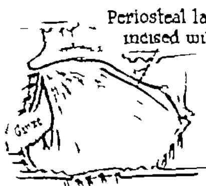
L Gauze sponge inserted at the line of incision to prevent oozing.

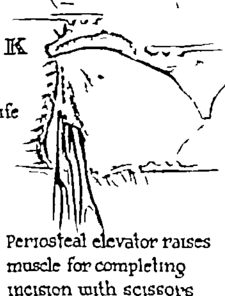
*(Continued on Plates 106 to 108)*


H
Base of scalp flap is
mobilized with scalpel


Gauze roll is placed under flap
I


J
Gutta
perch
Gutta-percha applied to
surface of flap and
self-retaining retrac
tors are then placed
Incision of temporal
m. begins with knife


L
Periosteal layer
incised with knife


K
Periosteal elevator raises
muscle for completing
incision with scissors

M Burr openings are made as outlined.

N Right-angled periosteal elevator used to free the dura around the edges of the burr openings

O Montenovesi rongeur used to undercut the edges of the burr openings to facilitate the placement of saws.

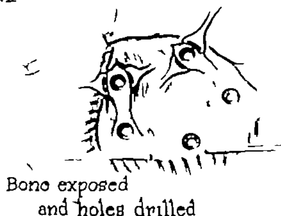
P Undercut edges of the burr openings insertion of the Gigli saws.

Q Connecting the burr openings by the Gigli saw

At the present time a special guide is used Two Gigli saw guides are permanently attached to each other obviating the use of two separate guides.

*(Continued on Plates 107 and 108)*

M



Bone exposed and holes drilled

N



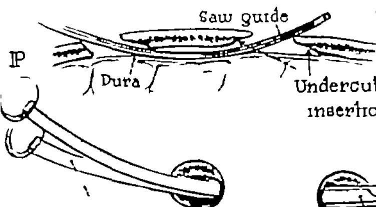
Right-angled dural separator to free dura around edges of burr holes

O

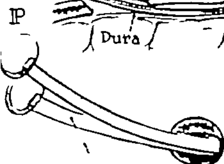


Undercutting edge of burr hole with Montenovesi rongeur

P




Undercutting facilitates insertion of saw guide

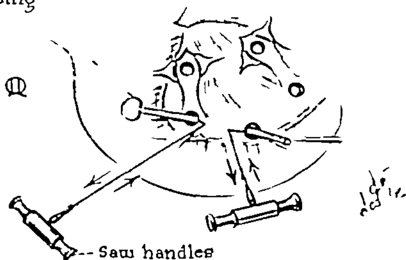


Guide remains to protect dura while sawing




Hook to pull saw through

Q



R and *Inset* Lower two openings extended with the Montenovesi rongeur

This tends to make the base of the bone flap break evenly

S Two bone elevators placed under the bone flap and raised partially

T Gauze sponge then placed at the edge of the bone flap to be broken.

*At the time the bone flap is being broken, exertion on the bone flap should be both* upward and with a pull toward the surgeon This must be done to prevent injury to the dura if the bone flap does not break evenly

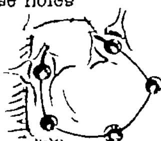
U Bone flap kept in place with self retaining retractors which have been removed from the previous position and replaced.

*(Continued on Plate 107)*

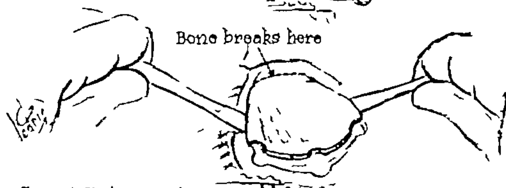
R

Montenovesi rongeur used in two base holes





S

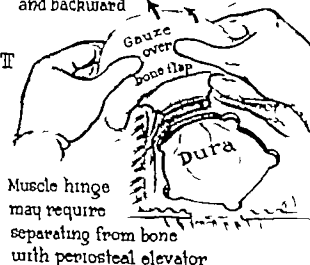



Bone flap is lifted upward and backward

Bone flap is raised by prying; base breaks under muscle hinge

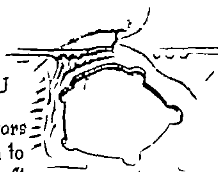
Sharp projections on broken edge must be rongeured off

T




Muscle hinge may require separating from bone with periosteal elevator

U



Scalp retractors repositioned to include bone flap

# CRANIOTOMY OPENING OSTEOPLASTIC FLAP

V Line of incision in the dura semicurved incision in the lower portion should correspond to the sylvian fissure anteriorly

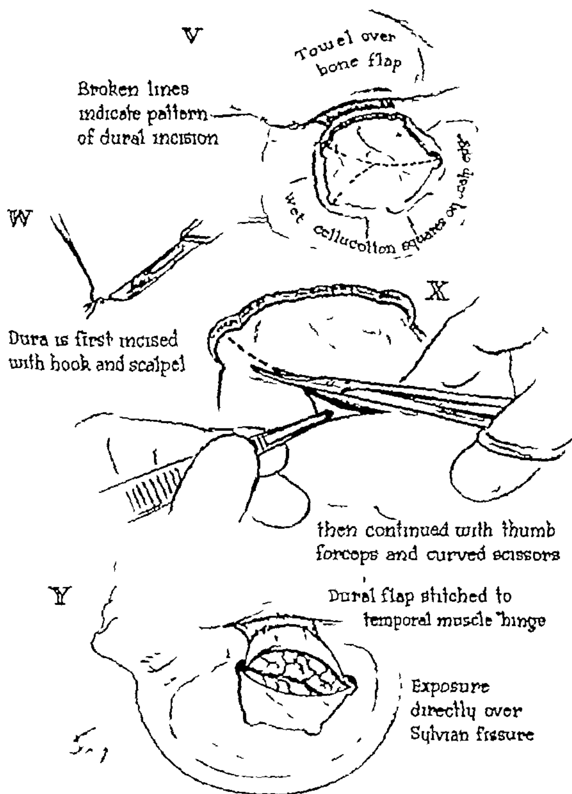
In most instances it is not necessary to open the upper line of incision

W Dura elevated with a dural hook and then incised.

X Completion of the opening of the dura is made with Metzenbaum scissors.

Y Lower flap of dura is attached to the temporal muscle, exposing the temporal lobe.

## CRANIOTOMY OPENING OSTEOPLASTIC FLAP



## CRANIOTOMY CLOSING OSTEOPLASTIC FLAP

A Bone flap separated from muscle tissue, leaving only the periosteum and fascia attached.

This prevents oozing from the bone flap.

Dura is closed with interrupted black silk and a catheter is allowed to remain in the cavity after the temporal lobe or tumor has been removed. The dura is tacked to the edge of the bone or galea this is particularly important on the inferior margins. Small Gelfoam pledgets can be placed under the retaining sutures

B Small drill openings are made in the bone flap at strategic points. Two perforations are made in the denuded portion of the bone flap and a single perforation is made immediately beneath the muscle.

*(Continued on Plates 110 to 112)*

# CRANIOTOMY CLOSING OSTEOPLASTIC FLAP

A

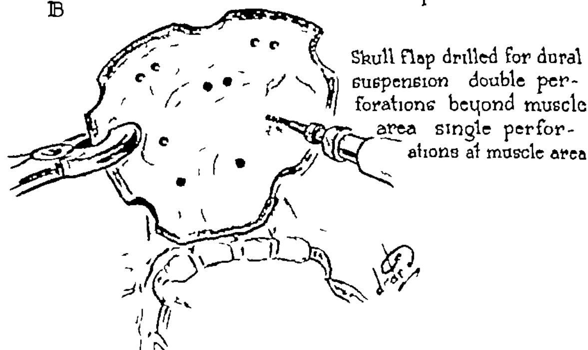
Separating muscle from skull flap as far as fascial attachment

Catheter in tumor cavity

Gelfoam over bone edge

Dura stitched to pericranium

B



C Bone flap temporarily replaced to allow accurate markings on the dura corresponding to the perforations.

D Silk sutures being placed through the dura and bone flap.

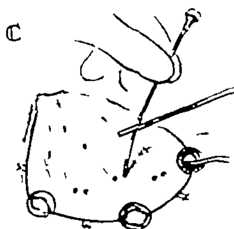
E Closure completed catheter is allowed to emerge through the posterior burr opening and is attached to the scalp with black silk in several figure-of-eight loops.

The purpose of the loops is to prevent the possible escape of the catheter from its position The more traction placed on the catheter the tighter the silk loops become.

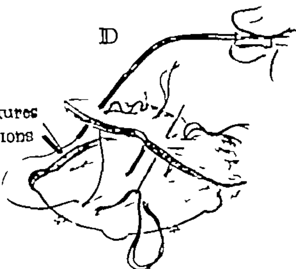
*Inset* Dura firmly attached to the bone flap by through-and-through sutures to prevent postoperative extradural clots.

Burr openings in exposed areas of the head are covered with stainless steel wire mesh or tantalum buttons the latter should not be used if silver clips have been used close to the surface or in its immediate surroundings.

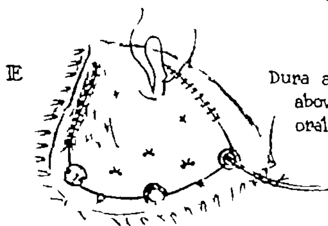
(*Continued on Plates 111 and 112*)




With skull flap lying in place stylet is inserted through perforations with tip touching dura Coagulating current is then applied to mark positions of perforations upon dura




Suction pulls silk sutures through flap perforations needle is used to bring sutures through where muscle is overlying




Dura anchoring sutures tied above skull flap and temporal muscle approximated

Tantalum button



Dura anchored to prevent epidural hematoma

F *a* Scalp flap replaced

*b c* and *d* Method of closure with interrupted black silk sutures.

G Alternate method of closure with end-on interrupted stainless steel wire sutures.

This method is used at the present time.

The two ends of wire are grasped approximately 1 cm. from the scalp edge with a hemostat and the hemostat is twisted until proper approximation of the scalp takes place.

(*Continued on Plate 112*)

## CRANIOTOMY CLOSING OSTEOPLASTIC FLAP

F

Scalp flap replaced with scratch-marks in apposition

a

b

c

Three Galea sutures placed

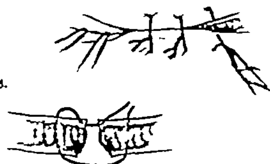
middle one trimmed and a skin suture is placed on each side of center mark

d

Surgeon continues scalp closure from one side of center while assistant closes from other side

G

With alternate closure scalp is closed in one layer using wire sutures.

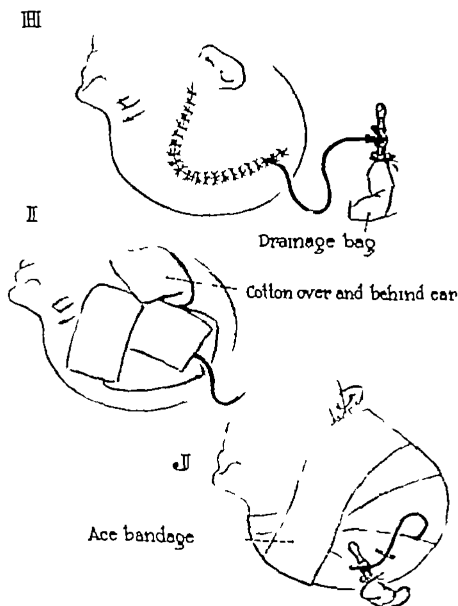


H Closure completed. A rubber bag with a three-way pet cock with a rubber nipple fastened to one edge is attached to the catheter by means of a blunt 18 gauge needle this permits insertion of a needle, allowing fluid to be removed from the drainage bag without contamination.

I For adequate protection, cotton must be placed over and behind the ear

*This prevents a painful ear resulting from the head bandage, which can occur if the* Ace bandage has been applied too snugly

J Completion of head bandage.


H
Drainage bag
I
Cotton over and behind ear
J
Ace bandage

## OBTAINING DURAL GRAFT FROM SCALP FLAP

A Periosteum freed from the scalp flap by inserting the scissors beneath the periosteum.

B
C Narrow edge of periosteum allowed to remain on the scalp flap and removal of the periosteal graft completed.

D Periosteum sutured to the edges of the dura and excess tissue removed.

# OBTAINING DURAL GRAFT FROM SCALP FLAP

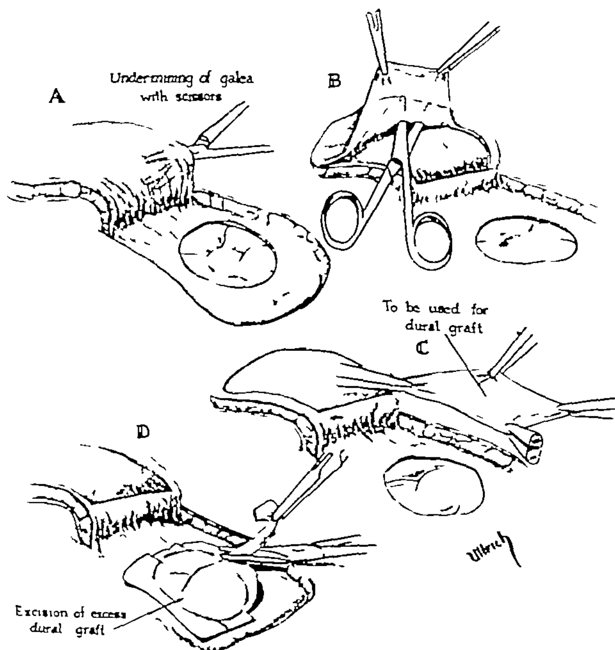



Plate 113

The right side is used for elective subtemporal decompression.

A Linear slightly oblique incision extends from the zygomatic process to the fascial attachment of the temporal muscle.

B Area to be removed from the squamous portion of the temporal bone.

C Scalp incised to fascia covering the temporal muscle Clamps are placed on the superficial fascia and digital compression on each side of the incision is released. The fascia is incised

A periosteal elevator is inserted in this opening and the temporal muscle elevated so that it can be readily divided with scissors, as demonstrated in the technique for Craniotomy Opening Osteoplastic Flap (Plate 105)

D The muscle is separated from the squamous portion of the temporal bone with a periosteal elevator the handle of the periosteal elevator is raised to allow insertion of Cushing s subtemporal decompression retractors Two burr openings are made and the intervening brid of bone is removed with rongeur

This facilitates formal removal of bone.

*(Continued on Plate 11*

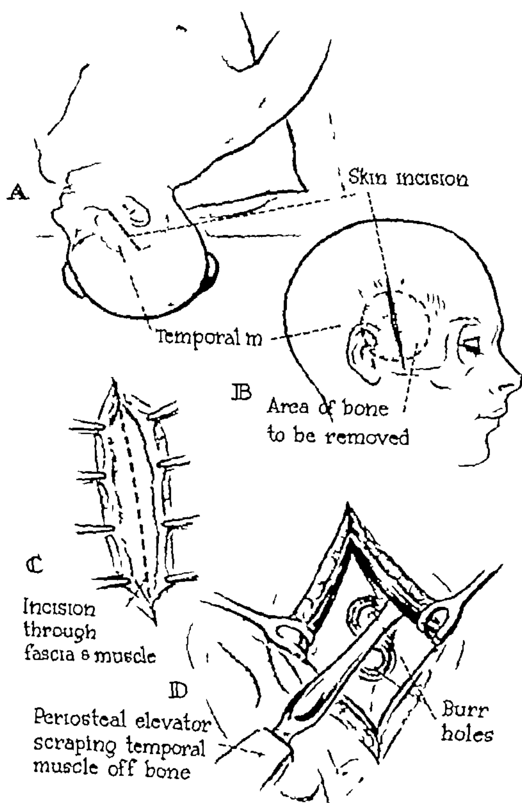

A
Skin incision
Temporal m
B
Area of bone
to be removed
C
Incision
through
fascia & muscle
D
Periosteal elevator
scraping temporal
muscle off bone
Burr
holes

Plate 114

E Removal of bone in quadrants, starting with segment 1

This simplifies removal of bone, and after the quadrant of bone has been removed bone wax is applied to the bone edge. Segment 2 is removed next, followed by the third and fourth quadrants. Bone from the two lower quadrants is removed to the base of the skull.

The only possible difficulty with bleeding may occur in the region of the pterion At times the middle meningeal artery lies imbedded and may be torn with the rongeur This point can be readily controlled by placing a glass suction tip to the point of bleeding, thus allowing the vessel to be occluded with the electrosurgical unit. Bleeding from the bone edge is controlled with wax.

F The dura is opened in segments, following the same rotation as in removal of bone.

G
H Closure made with several layers of interrupted black silk

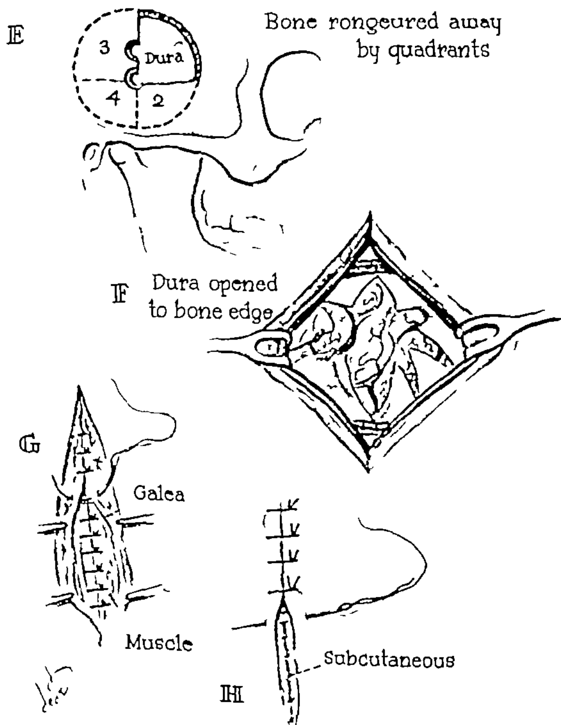

E
3
Dura
4
2
Bone rongeured away by quadrants
F
Dura opened to bone edge
G
Galea
Muscle
H
Subcutaneous

Plate 115

A Type of incision and bone flap

B Dura reflected toward the midline atrophic brain

C Cerebral hemisphere retracted laterally exposing the fronto-polar artery

D Fronto-polar vessels divided between clips, care being taken to preserve the callosal artery

(*Continued on Plates 117 and 118*)

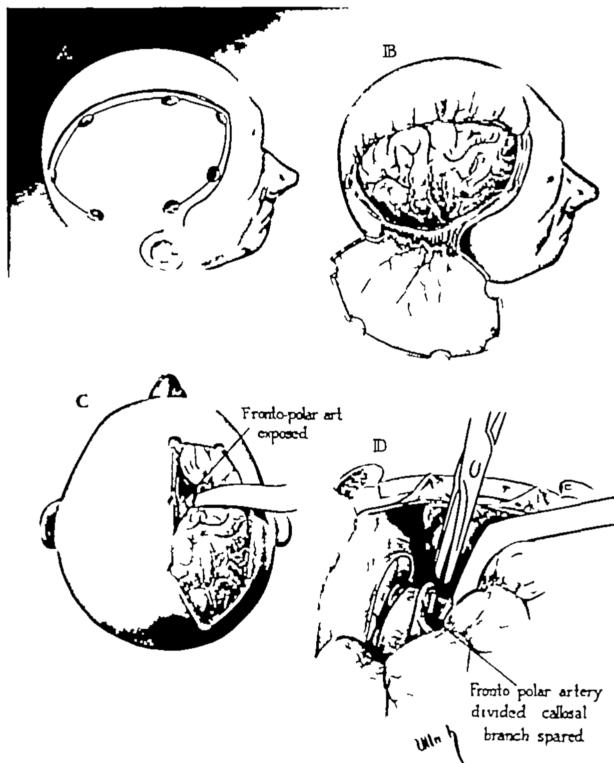

A
B
C
Fronto-polar art
exposed
D
Fronto polar artery
divided callosal
branch spared

Plate 116

E Sylvian fissure separated. The middle cerebral artery is occluded and divided distal to vessels entering the basal ganglia.

F Cross section of dilated ventricular system The middle cerebral artery is divided and penetrating vessels to the basal ganglion spared.

G The temporo-occipital lobe is now partially elevated to expose the veins of Labbé, which are occluded with the electrosurgical unit and divided

H The posterior cerebral artery is exposed by elevating the temporo-occipital lobe and divided between clips as it emerges from the hiatus tentorium.

(*Continued on Plate 118*)

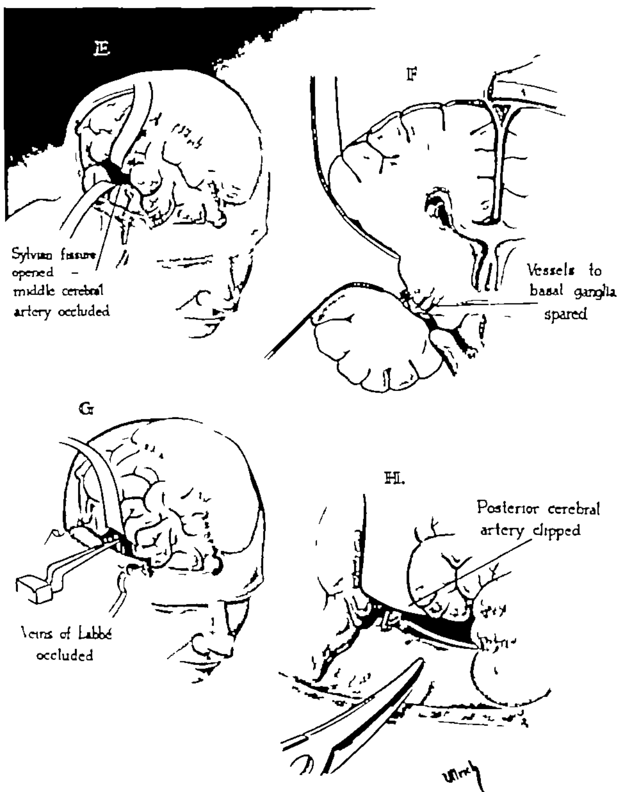

E
F
Sylvian fissure opened – middle cerebral artery occluded
Vessels to basal ganglia spared
G
H
Posterior cerebral artery clipped
Veins of Labbé occluded

Plate 117

**E** Sylvian fissure separated The middle cerebral artery is occluded and divided distal to vessels entering the basal ganglia.

**F** Cross section of dilated ventricular system The middle cerebral artery is divided and penetrating vessels to the basal ganglion spared.

**G** The temporo-occipital lobe is now partially elevated to expose the veins of Labbé, which are occluded with the electrosurgical unit and divided.

**H** The posterior cerebral artery is exposed by elevating the temporo-occipital lobe and divided between clips as it emerges from the hiatus tentorium

*(Continued on Plate 118)*

Plate 117

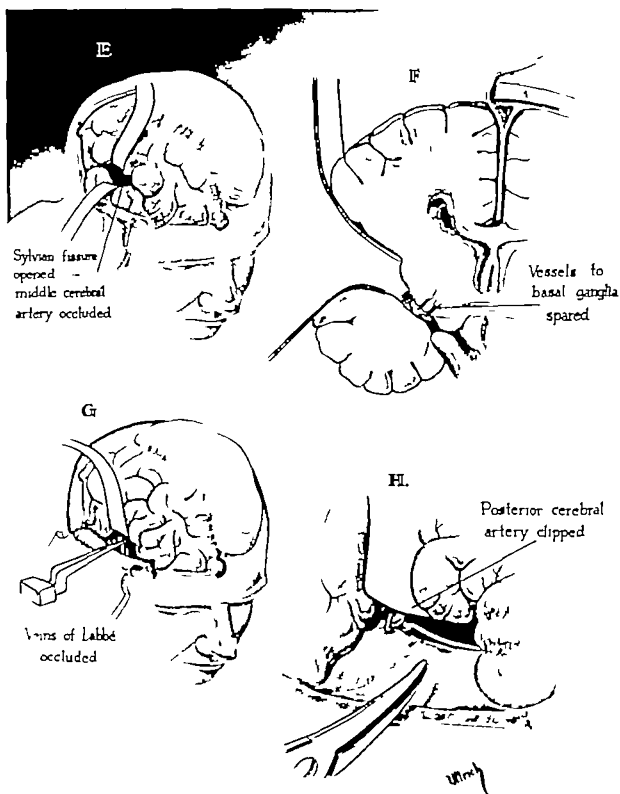

E
F
Sylvian fissure opened - middle cerebral artery occluded
Vessels to basal ganglia spared
G
H.
Posterior cerebral artery clipped
Veins of Labbé occluded

Plate 117

I Cortical veins entering the sagittal sinus occluded and divided.

J Hemisphere retracted from the falx, exposing the parietal portion of the corpus callosum which is then incised at dotted line, exposing the ventricle.

Incision is carried anteriorly through the genu of the corpus callosum and posteriorly through the *splenium of the corpus callosum* Continuing *the lateral retraction of the hemisphere,* the line of resection is shown skirting the basal ganglion.

K *Hemisphere removed dura closed, and bone flap replaced.*

Cavity catheter remains in place for drainage. The scalp is sutured with a single layer of interrupted end-on mattress sutures of stainless steel wire.

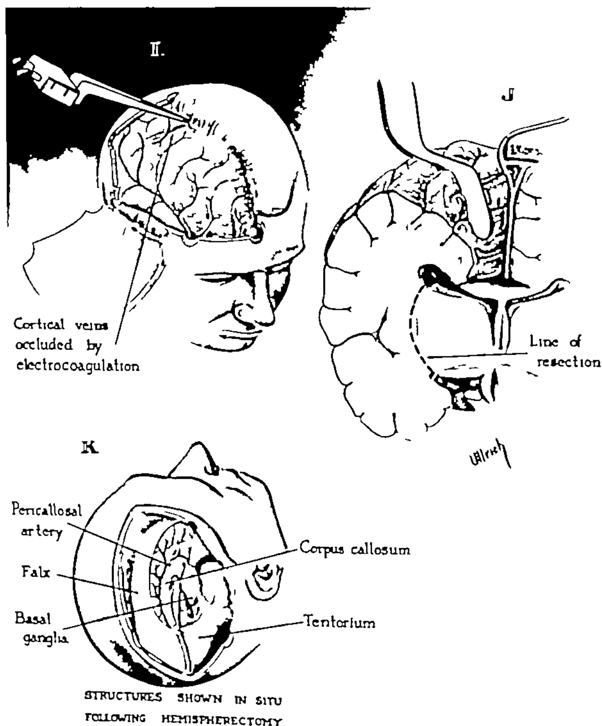

II.
J
K
Cortical veins
occluded by
electrocoagulation
Line of
resection
Pericallosal
artery
Falx
Basal
ganglia
Corpus callosum
Tentorium
STRUCTURES SHOWN IN SITU
FOLLOWING HEMISPHERECTOMY

Plate 118

# DECOMPRESSION OF THE TENTORIAL HIATUS BY INCISION OF THE TENTORIUM

A Patient placed in sitting position. A linear incision is made approximately midway between the medial portion of the mastoid process and the occipital protuberance immediately above the lateral sinus

B A trephine opening 2.5 cm. in length is made with the lower portion including the lateral sinus a dural incision is made.

C A ventricular needle is inserted into the dilated ventricle.

D A catheter is inserted for drainage.

E The occipital lobe is elevated and cortical veins to the sinus are coagulated

*(Continued on Plates 120 and 121)*

# DECOMPRESSION OF THE TENTORIAL HIATUS BY INCISION OF THE TENTORIUM

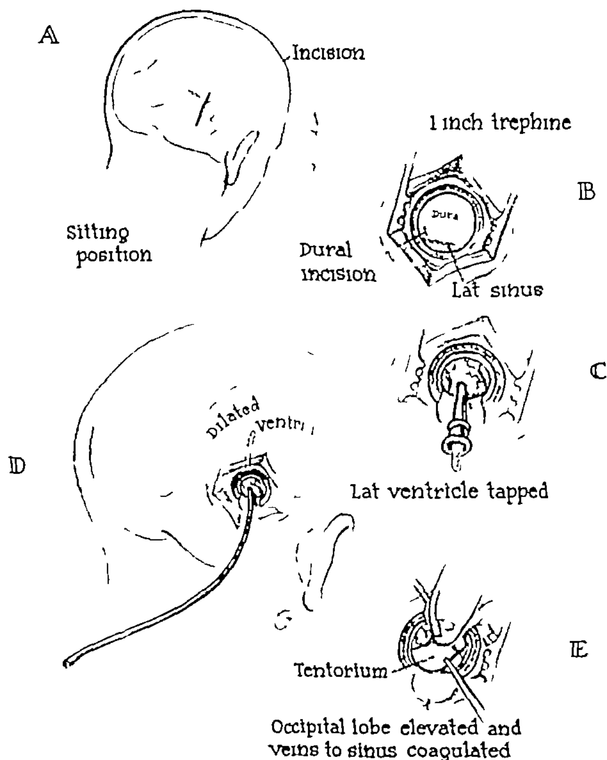



Plate 119

## DECOMPRESSION OF THE TENTORIAL HIATUS BY INCISION OF THE TENTORIUM

**A** Patient placed in sitting position. A linear incision is made approximately midway between the medial portion of the mastoid process and the occipital protuberance immediately above the lateral sinus.

**B** A trephine opening 2.5 cm. in length is made with the lower portion including the lateral sinus a dural incision is made.

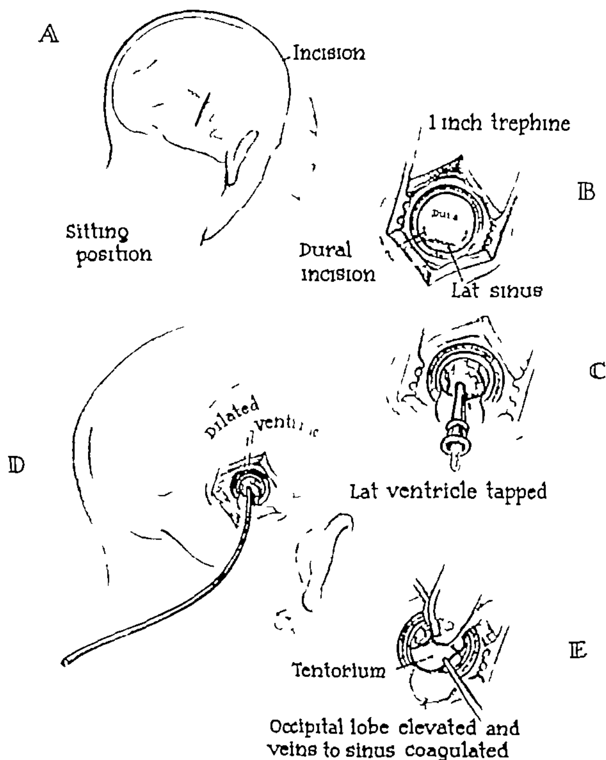
**C** A ventricular needle is inserted into the dilated ventricle.

**D** A catheter is inserted for drainage.

**E** The occipital lobe is elevated and cortical veins to the sinus are coagulated

*(Continued on Plates 120 and 121)*

# DECOMPRESSION OF THE TENTORIAL HIATUS BY INCISION OF THE TENTORIUM



## DECOMPRESSION OF THE TENTORIAL HIATUS BY INCISION OF THE TENTORIUM

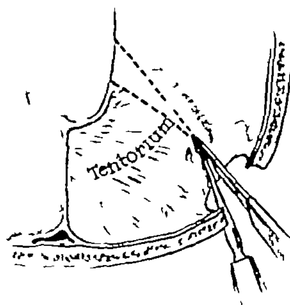
**F** *Tentorium elevated with dural hook approximately 2.0 to 3.0 cm posterior to its attachment* to the petrous bone.

**G**
**H** Wedge-shaped segment of dura removed.

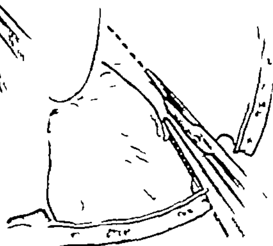
*(Continued on Plate 121)*

DECOMPRESSION OF THE TENTORIAL HIATUS BY
INCISION OF THE TENTORIUM

F

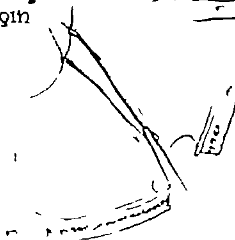



Incision started
with dural hook
and scalpel ---
continued with
forceps and scissors



G

Silver clips placed
before cutting
at free margin



H

# DECOMPRESSION OF THE TENTORIAL HIATUS BY *INCISION OF THE TENTORIUM*

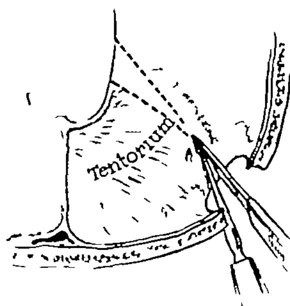
**F** *Tentorium* elevated with dural hook approximately 2.0 to 3.0 cm posterior to its attachment to the petrous bone.

**G**
**H** Wedge-shaped segment of dura removed

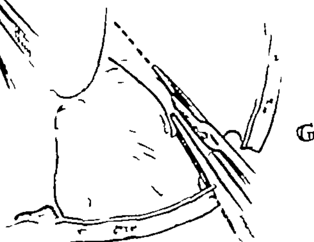
(*Continued on Plate 121*)

## DECOMPRESSION OF THE TENTORIAL HIATUS BY INCISION OF THE TENTORIUM

F

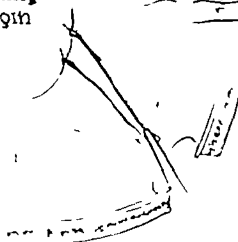



Incision started with dural hook and scalpel --- continued with forceps and scissors



G

Silver clips placed before cutting at free margin



H

## DECOMPRESSION OF THE TENTORIAL HIATUS BY INCISION OF THE TENTORIUM

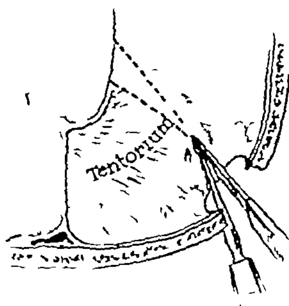
F Tentorium elevated with dural hook approximately 2.0 to 3.0 cm posterior to its attachment to the petrous bone.

G
H Wedge-shaped segment of dura removed

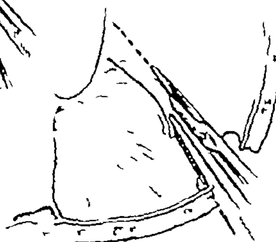
*(Continued on Plate 121)*

# DECOMPRESSION OF THE TENTORIAL HIATUS BY INCISION OF THE TENTORIUM

F

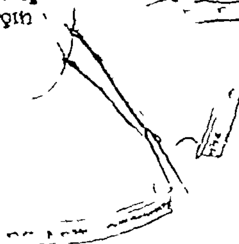



Incision started with dural hook and scalpel --- continued with forceps and scissors



G

Silver clips placed before cutting at free margin



H

## DECOMPRESSION OF THE TENTORIAL HIATUS BY INCISION OF THE TENTORIUM

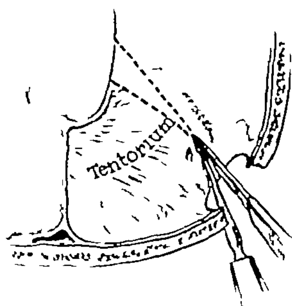
**F** Tentorium elevated with dural hook approximately 2.0 to 3.0 cm posterior to its attachment to the petrous bone.

**G**
**H** Wedge-shaped segment of dura removed.

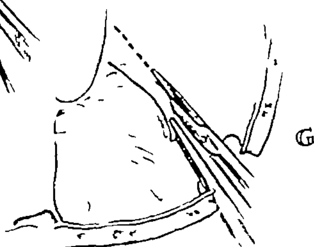
*(Continued on Plate 121)*

DECOMPRESSION OF THE TENTORIAL HIATUS BY INCISION OF THE TENTORIUM

F



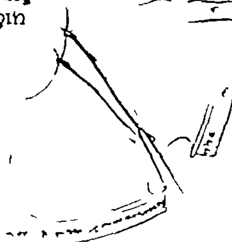

Incision started with dural hook and scalpel --- continued with forceps and scissors



G

Silver clips placed before cutting at free margin

H



# DECOMPRESSION OF THE TENTORIAL HIATUS BY INCISION OF THE TENTORIUM

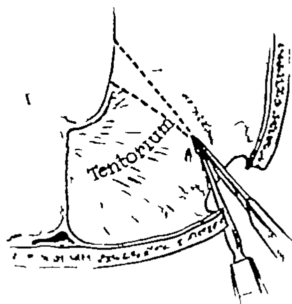
**F** Tentorium elevated with dural hook approximately 2.0 to 3.0 cm. posterior to its attachment to the petrous bone.

**G**
**H** Wedge-shaped segment of dura removed

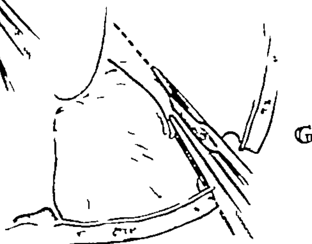
*(Continued on Plate 121)*

# DECOMPRESSION OF THE TENTORIAL HIATUS BY INCISION OF THE TENTORIUM

F

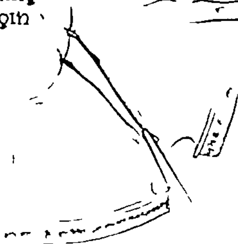



Incision started with dural hook and scalpel --- continued with forceps and scissors



G

Silver clips placed before cutting at free margin



H

# DECOMPRESSION OF THE TENTORIAL HIATUS BY INCISION OF THE TENTORIUM

**I** Adequate decompression and the normal structures

**J** Dural closure.

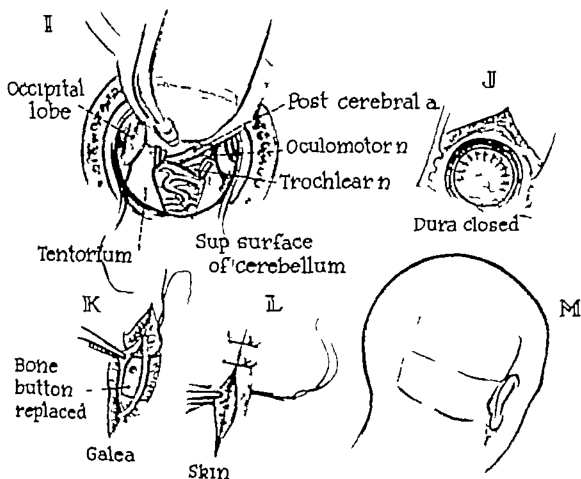
**K** Bone button replaced and galea sutured.

**L** Skin closure

**M** Dressing applied.

Tentorial incision or decompression is used in suspected pinealomas. The exploration can be carried out through the same opening and a biopsy taken of the tumor or if it is a degenerated lesion the bulk is aspirated. If a Torkildsen procedure seems necessary refer to Pinealoma (Plates 62 and 63)

# DECOMPRESSION OF THE TENTORIAL HIATUS BY INCISION OF THE TENTORIUM



# BIMEDIAL PREFRONTAL LOBOTOMY

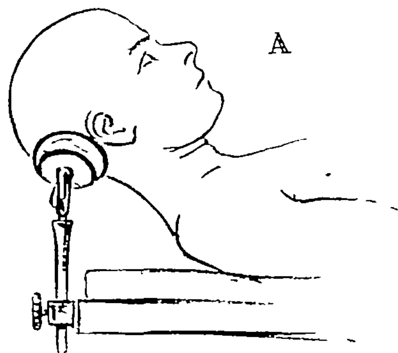
**A** Position of head

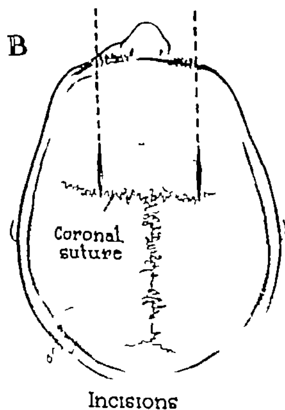
**B** Incisions.

With the patient under light Pentothal anesthesia the scalp is infiltrated with 1 per cent procaine in the region in which the incision is to be made. No elaborate measurements are taken since the dimensions of all skulls vary greatly Visible anatomical landmarks only are used, such as the pupil of each eye and the coronal suture line which is evident *after the scalp has been shaved. Two parallel incisions in the sagittal plane, usually* 4.0 cm. in length, are made in line with the pupil of each eye, extending just to the anterior border of the coronal suture on each side.

**C** Scalp edges and periosteum separated with a sharp periosteal elevator

*(Continued on Plates 123 to 126)*




Incisions




Bone bared with periosteal elevator

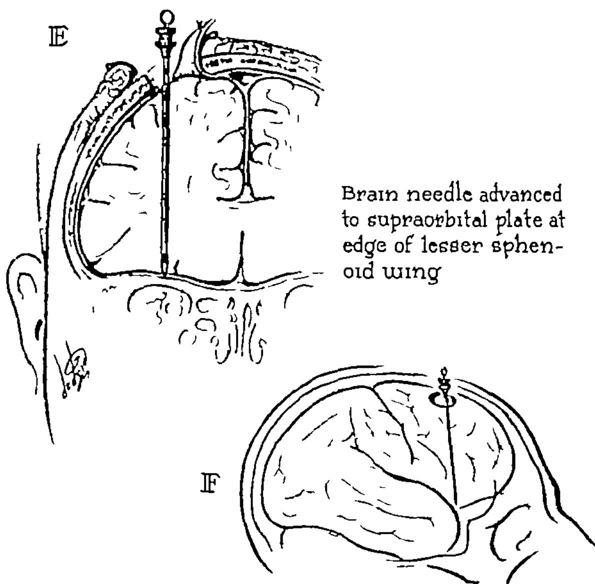
Plate 122

**E** A ventricular needle is inserted in the direction of the edge of the lesser sphenoid wing, in line with the anterior horn of the lateral ventricle. If the lateral ventricle is normal in size, the needle will just skirt the anterior edge of the anterior horn. If the ventricular system is *enlarged as the result of atrophy the ventricular needle may enter the ventricle. It is a* simple matter to withdraw the needle and direct it slightly more anteriorly

**F** Lateral view of needle in place.

The needle tract serves as a guide both in the location of the ventricle and also for the desired plane of leukotomy The needle tract is then followed with the electrosurgical suction instrument. After a wedge of cortex has been removed the white tissue is divided by a sweeping motion from side to side.

*(Continued on Plates 125 and 126)*

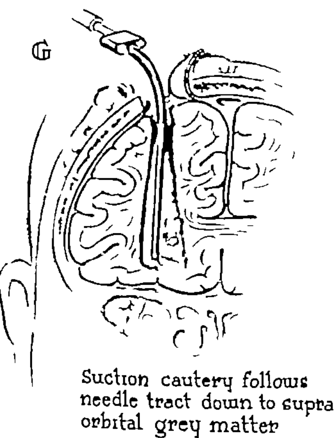

E
Brain needle advanced to supraorbital plate at edge of lesser sphenoid wing
F

G The needle tract has been widened.

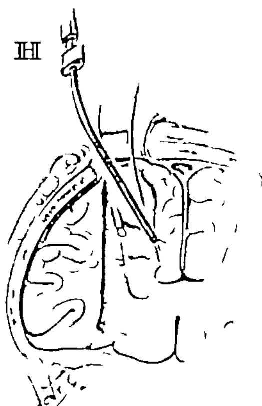
This procedure is performed under direct vision care being taken that all tiny bleeding vessels are controlled. In most individuals there are few bleeding points in others, however the tiny vessels in the white tissue may be numerous, especially just anterior to the tip of the lateral ventricle.

H Care is taken to be certain that all white tissue is divided on the medial inferior quadrant to the lateral ventricle. Digitations of the white tissue in the gyri are divided under direct vision with the electrosurgical unit, leaving the cortex intact. Incisions made through the white tissue are thoroughly irrigated with saline solution to remove small bits of fragmented brain.

*(Continued on Plate 126)*




Suction cautery follows needle tract down to supra orbital grey matter



I The dura is closed with two interrupted black silk sutures and a hammock of Gelfoam is placed immediately beneath the dural flap This serves to seal the loosely sewed dura and prevents blood from entering the cranial cavity after operation. Gelfoam is then placed along the edges of the bone, and the bone trephine buttons are replaced.

J Closure of galea.

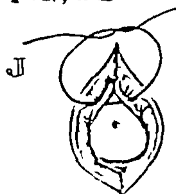
K Scalp is sutured with two layers of interrupted black silk. A light dressing is firmly attached with the elastoplast bandage.

I

Gelfoam Strips

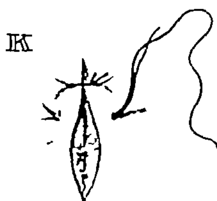
Dura

J



Closure of galea over replaced bone button

K



Closure of scalp

Temporary closure of the eyelids is essential to prevent corneal abrasions and excessive herniation of the edematous conjunctiva. The sutures are placed immediately following the introduction of the anesthetic agent and before formal draping of the patient for orbital decompression.

A Mattress silk suture inserted through the center of the free edge of the eyelids each loop should emerge at least 4 mm. from the edges.

B Gutta-percha strip placed beneath each loop of silk as the loop is being tied.

C Central portion of gutta percha excised to prevent localized pressure necrosis from pressure bandage

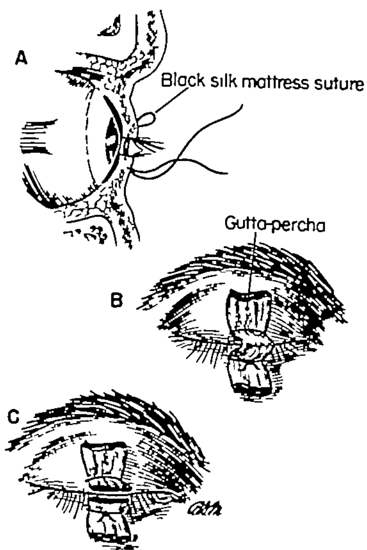



Plate 127

# PERMANENT CANTHORRHAPHY

In rare instances, ulcerations of the cornea resulting from dysfunction of the seventh and fifth cranial nerves must be treated by prolonged closure of the eyelids. This is performed in the following manner

A Incisions made with a sharp-pointed knife in the free edges of the eyelids.

B Wedge of tissue removed from the free edges of the eyelids.

C Mattress sutures inserted through the exact center of the denuded areas.

D Denuded areas in the free edges of the eyelids are brought together

> Great care must be taken while tying the silk sutures to avoid burning the cornea by friction A piece of gutta percha is inserted under each loop and the silk sutures snugly tied. The eyelashes are left *in situ* and the sutures left in place for seven days. The denuded areas should be firmly united by that time.

If desirable the eyelids can be readily reopened later by dividing the narrow segments of new tissue. At times only canthorrhaphy on the lateral border of the eyelid may be desirable.

When permanent closure in the medial aspect of the eyelid is performed, careful attention must be given to the openings of the lacrimal ducts so that they are not injured

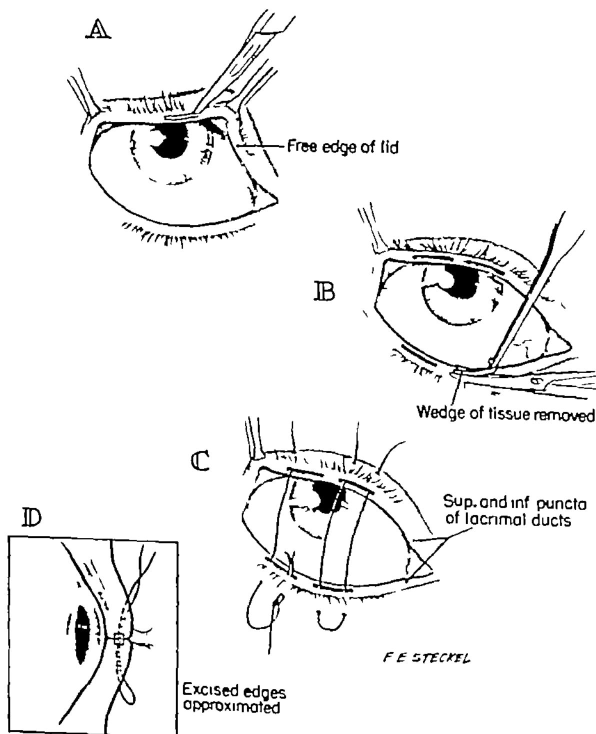

A
Free edge of lid
B
Wedge of tissue removed
C
Sup. and inf puncta of lacrimal ducts
D
Excised edges approximated
F E STECKEL

Plate 128

# BILATERAL ORBITAL DECOMPRESSION

**A** Modified coronal incision It is important to make the incision well behind the if too close to the hairline, the result is unbecoming until the hair is long enougl the scar In a bald patient, the *incision should be made considerably farther post* that the well healed incision is not perceptible when the head is in an upright p the incision is made in the frontal region it becomes more noticeable.

**B** A triangular bone flap is made bilaterally

**C** The bone flap should be broken down as low as possible in the region of the zygo

**D** The dura is separated from the orbital plate and elevated and the temporal bone *anteriorly as far as possible.*

**E** A burr opening is then made over the orbital plate. Usually the roof of the orb thin because of intraorbital pressure from the exophthalmos. In many instances a shell is present, in which case it is not necessary to use the electric drill Care is t the orbital fascia is not opened. The roof of the orbit, including the sphenoid win removed with rongeurs.

**F** The lateral wall of the orbit can be readily rongeured away after the roof has been

*(Continued on Plates 130*

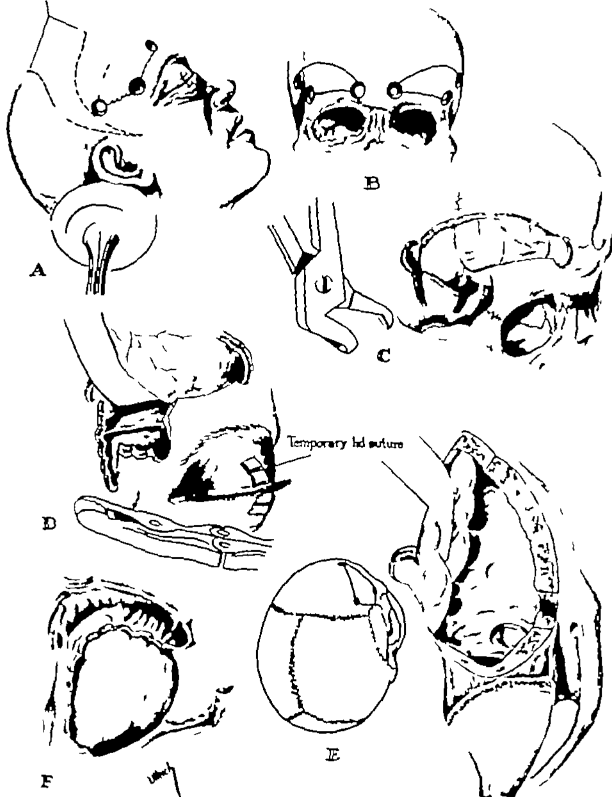



Plate 129

**G** Removal of the inferior portion of the orbital rim with a Kerrison punch. If there is an extension of the frontal sinus into the orbital plate (as in Plate 133 C 1) the superior and inferior walls of the sinus are removed and the mucous membrane enfolded and reinforced with Gelfoam, as shown in the postoperative view (Plate 133 C 2) This provides better decompression of the orbital content

**H** The area of incision into the periorbital fascia. The first opening is made along the lower margin (the line marked 1 on the drawing). The anterior portion encircles the lacrimal gland. An opening is next made over the midline (line 2) and then the incision shown as line 3

**I** A lateral view of the field with the first incision about to be started

**J** The remaining strand of fascia is severed (line 4)

The reason for making the incision in the inferior lateral portion initially is the marked bulging of tissue, which may represent either edematous fat or greatly thickened muscles (see Plate 132, B) The orbital fascia is opened up to the annulus of Zinn It is preferable not to open the annulus of Zinn since extraocular muscle palsies may occur as a result. The periorbital flaps may be placed over any sinus that is open however the mucous membrane should be inverted and Gelfoam placed over the opening, then reinforced by laying the orbital fascia or flaps over this.

**K** Demonstration of the bulging, fatty tissue. The bone flaps are replaced and a catheter is inserted through the antero-inferior burr opening.

*(Continued on Plate 131)*

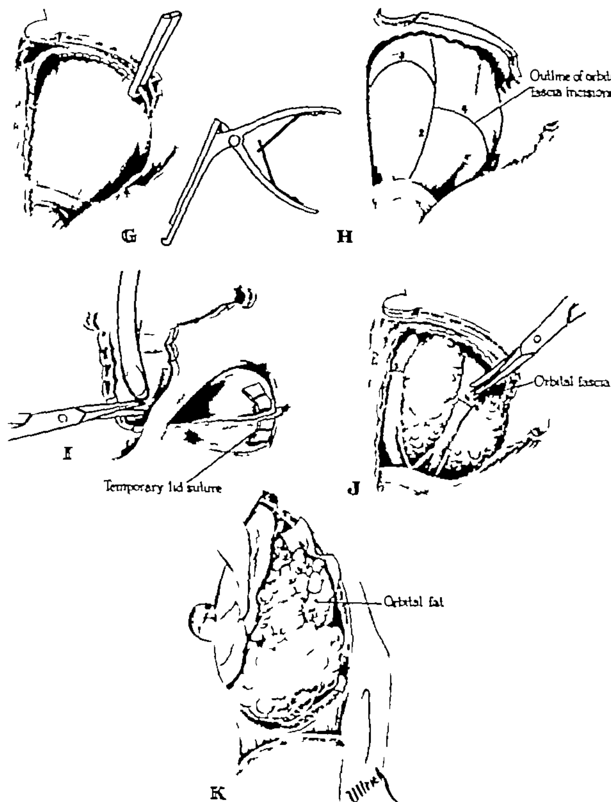

Outline of orbital fascia incisions
G
H
Temporary lid suture
I
Orbital fascia
J
Orbital fat
K

Plate 130

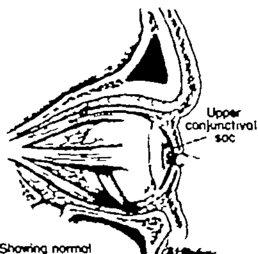
A The normal relationship of the eyeball and orbital tissues to the surrounding structures. Note the upper and lower conjunctival sacs.

B Variations in the pathologic conditions noted at the time of surgery Figure 1 demonstrates a marked increase in the edema of the fatty tissue figure 2 shows the enlargement of the individual orbital muscles, with very little fat.

*(Continued on Plates 133 and 134)*

# PROGRESSIVE EXOPHTHALMOS

**A** NORMAL EYE




**B** EXOPHTHALMOS

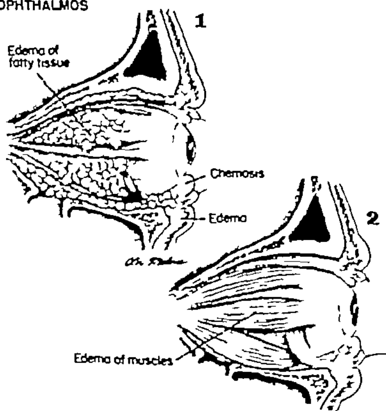



Plate 132

C Preoperative and postoperative views. Particular emphasis is placed on the frontal sinus which projects well over the orbital plate at times it (as well as the ethmoid sinuses) may extend for a considerable distance. The upper and lower margins of the sinus walls are removed. Preferably the mucous membrane is kept intact and inverted. If it is not kept intact, it is gently separated with a periosteal elevator imbricated, and reinforced with Gelfoam The orbital fascia which has been incised is also used to reinforce this.

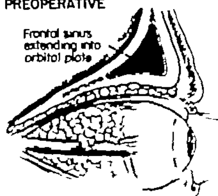
D Preoperative and postoperative views of the frontal sinus which is within normal limits. The bone should be removed as close as possible to the frontal sinus however it is not necessary to open the sinus.

*(Continued on Plate 134)*

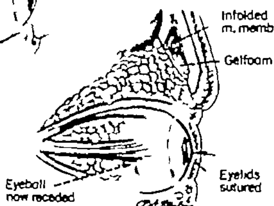
PROGRESSIVE EXOPHTHALMOS

C ENLARGED FRONTAL SINUS

1 PREOPERATIVE

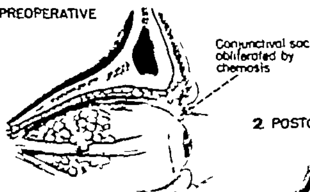



2 POSTOPERATIVE




D SMALL FRONTAL SINUS

1 PREOPERATIVE




2 POSTOPERATIVE




Plate 133

# PROGRESSIVE EXOPHTHALMOS

**A** Preoperative photograph of patient demonstrating severe chemosis of the conjunctiva, swelling of the upper and lower eyelids and severe vertical creases between the eyebrows.

**B** Preoperative lateral view demonstrating proptosis and hemorrhagic chemosis.

**C** Postoperative view three weeks after operation demonstrating recession of eyeball and chemosis.

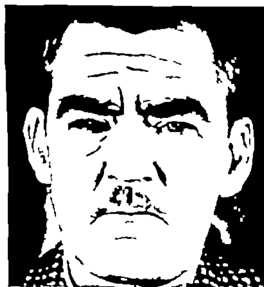
**D** Postoperative lateral view



A



B



C



D

Plate 134

# INFRATENTORIAL SECTION OF LOWER CRANIAL NERVES

Fifth Eighth and Ninth Nervi Intermedii

**A** Patient in sitting position type of incision and area of bone to be removed.

**B** Separation of muscle from occipital bone.

**C** Multiple burr openings made and connected with rongeur

> *With the patient in a sitting position all emissary veins must be occluded and the diploic portions of the bone edges sealed with wax to prevent air embolus.*

**D** Type of opening in dura on the left for a right handed surgeon

**E** Dural opening to be made on right side this facilitates closure of the dura after nerve section has been completed

*(Continued on Plates 136 to 138)*

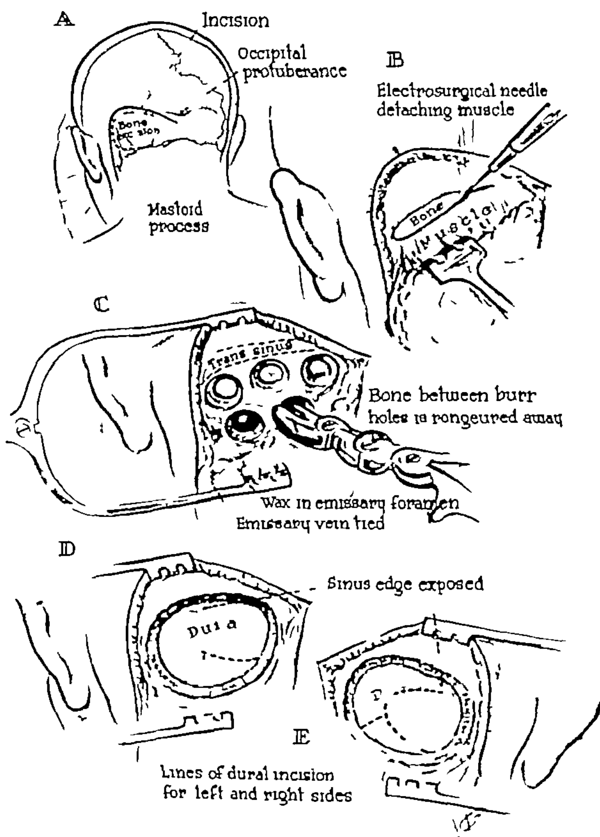

A
Incision
Occipital
protuberance
Bone
Mastoid
process
B
Electrosurgical needle
detaching muscle
Bone
Muscle
C
Trans sinus
Bone between burr
holes is rongeured away
Wax in emissary foramen
Emissary vein tied
D
Sinus edge exposed
Dura
E
Lines of dural incision
for left and right sides

Plate 135

# INFRATENTORIAL SECTION OF LOWER CRANIAL NERVES

## Fifth Eighth and Ninth Nervi Intermedii

F Dura opened and edges sutured to the subcutaneous tissues for retraction cistern opened over the lower cranial nerves.

G Petrosal vein occluded with electrosurgical unit and divided, exposing the fifth cranial nerve

H Fifth nerve now divided partially or completely

I The ninth cranial nerve is readily identified since it is distinctly separate from the tenth cranial nerve.

In most instances there is a space of 2 to 3 mm. between the upper fibers of the ninth and tenth nerves. The ninth cranial nerve can be readily divided with a sharp knife.

*(Continued on Plates 137 and 138)*

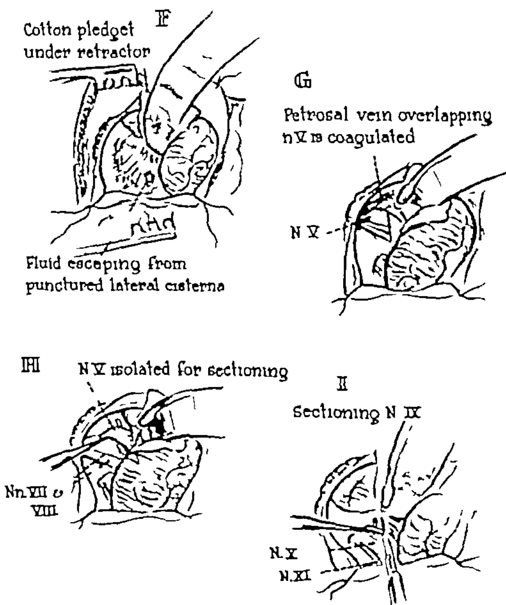

F
Cotton pledget under retractor
Fluid escaping from punctured lateral cisterna
G
Petrosal vein overlapping n V is coagulated
N V
H
N V isolated for sectioning
Nn VII & VIII
I
Sectioning N IX
N X
N XI

Plate 136

## INFRATENTORIAL SECTION OF LOWER CRANIAL NERVES

### Fifth, Eighth and Ninth Nervi Intermedii

**J** Relationship of the seventh and eighth cranial nerves to the nerve of Wrisberg.

**K** Nerve of Wrisberg isolated by separating the seventh and eighth cranial nerves.

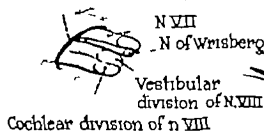
It may be made up of one single fiber or two individual fibers. At times it is more easily exposed by elevating the eighth nerve slightly and separating it from below rather than from above as indicated.

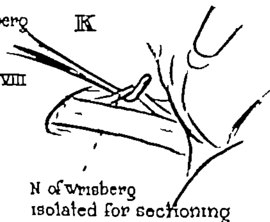
**L** Eighth nerve separated from the seventh nerve and partially or completely divided.

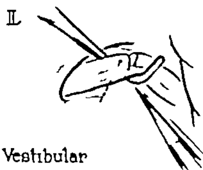
*If the patient is deaf, complete section is indicated.*

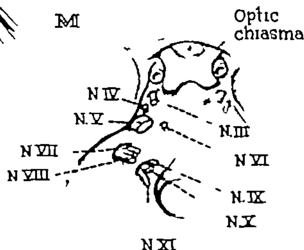
**M** Anatomical view of the base of the posterior fossa, indicating the relationship of the various cranial nerves.

*(Continued on Plate 138)*


J
Internal auditory meatus
N VII
N of Wrisberg
Vestibular
division of N VIII
Cochlear division of n VIII


K
N of Wrisberg
isolated for sectioning


L
Vestibular
portion of n VIII
sectioned with
hook & scalpel


M
Optic
chiasma
N IV
N V
N III
N VII
N VI
N VIII
N IX
N X
N XI

N The dura must be closed watertight with interrupted black silk sutures.

O The scalp is closed either with two interrupted layers of black silk sutures or with a single
P through-and-through end-on mattress stainless steel wire

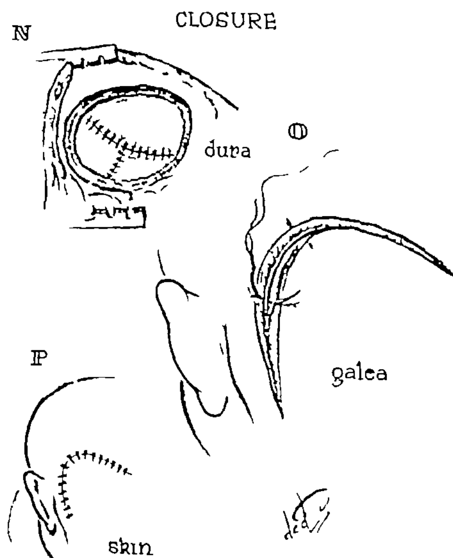



Plate 138

A With the patient under endotracheal anesthesia and the head extended indigo carmine solution is inserted into the nostril from which the fluid has escaped. If rhinorrhea is bilateral, the solution is injected into each nostril.

*Indigo carmine often gives a valuable clue to the location of the fistula after the intra* cranial exposure has been made.

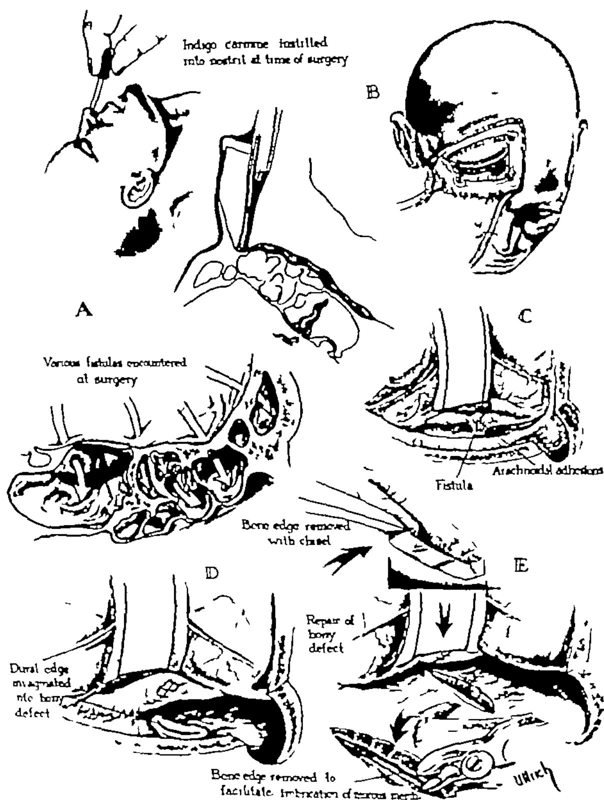
B Type of scalp and osteoplastic bone flap The dura is opened in a crescentic single incision.

C The frontal lobe is elevated and in most instances an obvious defect may be seen If the condition is longstanding, the arachnoidal adhesions which have formed are separated from the dura

D The dura is disengaged from the orbital and cribriform plates. The edge of dura adherent to the bone opening is incised and the dural defect is closed with interrupted black silk.

E Edges of the bony defect are enlarged with a chisel and then with a rongeur This allows the mucous membrane to be separated from the sinus, imbricated and reinforced with Gelfoam and muscle.

*(Continued on Plates 140 and 141)*


Indigo carmine instilled
into nostril at time of surgery
B
A
C
Various fistulas encountered
at surgery
Fistula
Arachnoidal adhesions
Bone edge removed
with chisel
D
E
Repair of
bony
defect
Dural edge
invaginated
into bony
defect
Bone edge removed to
facilitate imbrication of mucous memb.

F Rupture of the dura with evagination of the arachnoid through the dura into the sinus.

*Inset* The spinal fluid can be seen weeping through the herniated porous portion of the arachnoid.

G The dural edge immediately surrounding the fistula is incised and a wedge of bone removed with chisel.

H Mucous membrane is separated from the wall of the sinus and invaginated

I Insertion of Gelfoam.

J Reinforcement with muscle.

K The scalp incision is closed in the usual manner and a drainage tube inserted in the region of repair

*(Continued on Plate 141)*

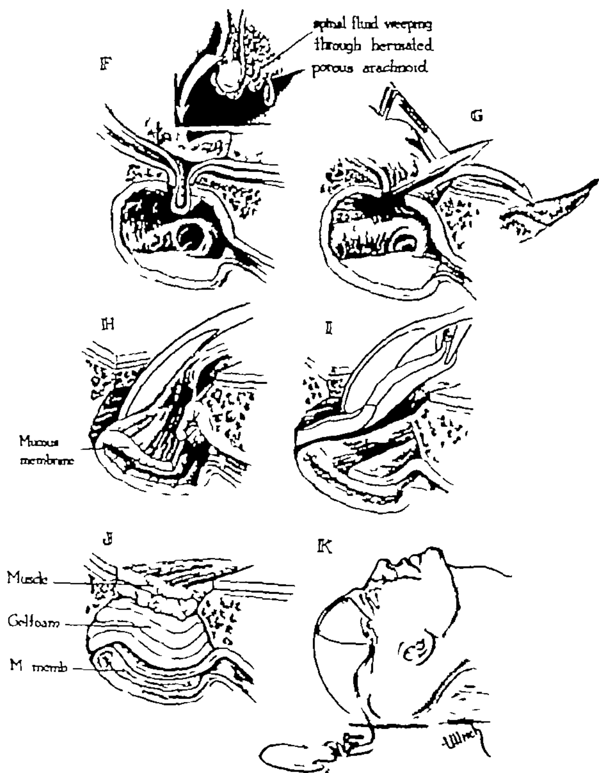

F
spinal fluid weeping
through herniated
porous arachnoid
G
H
Mucous
membrane
I
J
Muscle
Gelfoam
M memb
K

Plate 140

**F** Rupture of the dura with evagination of the arachnoid through the dura into the sinus.

*Inset* The spinal fluid can be seen weeping through the herniated porous portion of the arachnoid.

**G** The dural edge immediately surrounding the fistula is incised and a wedge of bone removed with chisel.

**H** Mucous membrane is separated from the wall of the sinus and invaginated.

**I** Insertion of Gelfoam

**J** Reinforcement with muscle.

**K** The scalp incision is closed in the usual manner and a drainage tube inserted in the region of repair

(*Continued on Plate 141*)

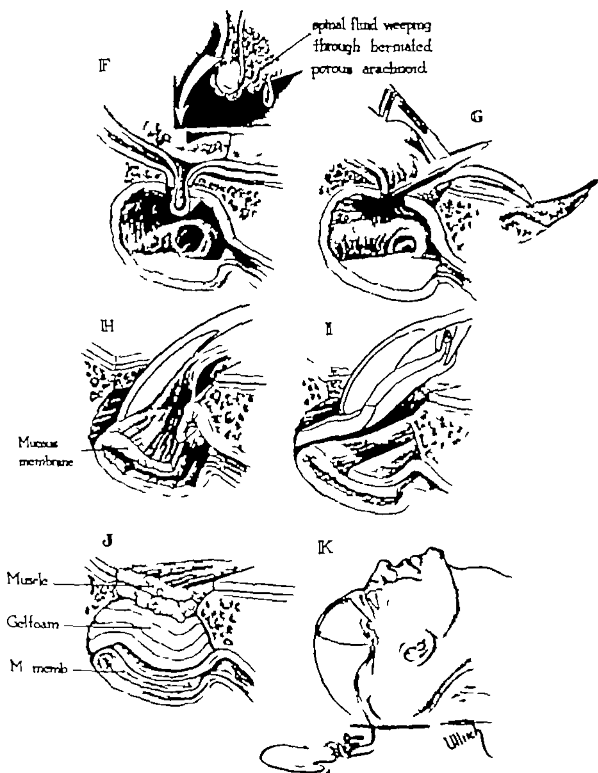

F
spinal fluid weeping
through herniated
porous arachnoid
G
H
I
Mucous
membrane
J
K
Muscle
Gelfoam
M memb

Plate 140

*Repair of Frontal Sinus*

*Method I (Open)*

**A** Opening made through mucous membrane of the frontal sinus by burr

**B**
**C** Separation of the mucous membrane from sinus wall.

The imbricated mucous membrane heals rapidly

**D** Reinforcement of mucous membrane with Gelfoam and a small piece of periosteum or muscle.

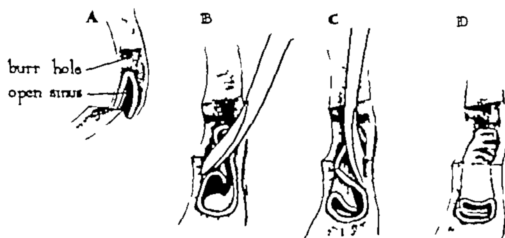
*Method II (Closed)*

**A** *Burr opening has skirted the mucous membrane without actually opening it.*

**B** Mucous membrane separated from the sinus wall and reinforced with Gelfoam.

This avoids postoperative rhinorrhea or cerebrospinal fistula

I




II

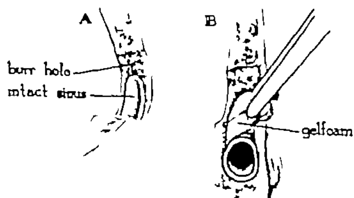


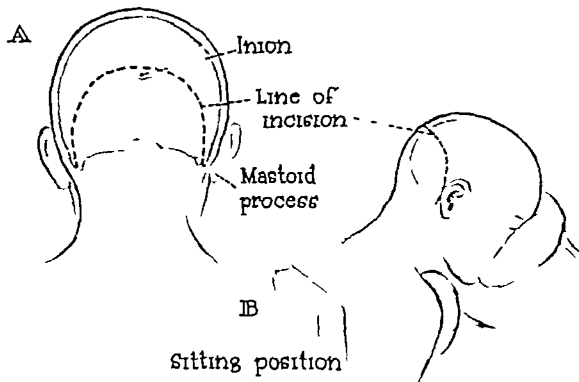

Plate 141

**A** Patient in sitting position type of incision.

**B** Lateral view

**C** Scalp incision made to the depth of the bone and curved forceps applied to the galea. Bleeding from edges controlled with digital compression

(*Continued on Plates 143 to 147*)


A
Inion
Line of incision
Mastoid process
B
Sitting position

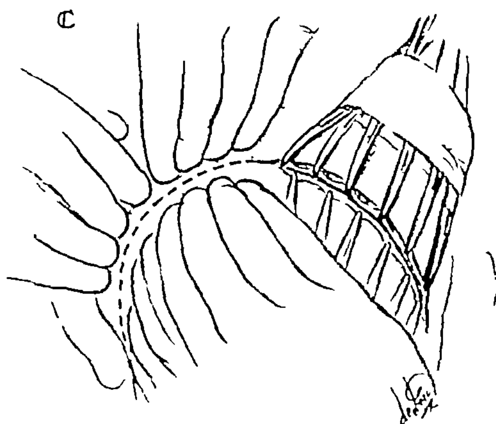

C

Plate 142

**D** Muscle separated from bone with electrosurgical cutting knife.

**E** All spaces and foramina, as well as gaping veins, are carefully occluded to prevent air embolus. Multiple burr openings are made to facilitate removal with rongeur

*(Continued on Plates 144 to 147)*



)

D

Inion

Occipital bone

Electrosurgical separation of muscle attachment

E

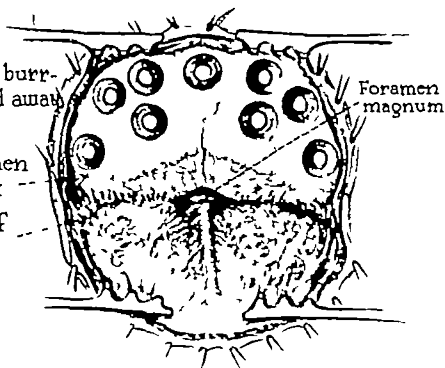



Plate 143

## SUBOCCIPITAL EXPLORATION (CEREBELLAR EXPLORATION)

**F** Dura opened as indicated.

**G** Right cerebellopontine angle explored

**H** Exploration of left side follows.

**I** Superior margin of the right cerebellar hemisphere must be inspected.

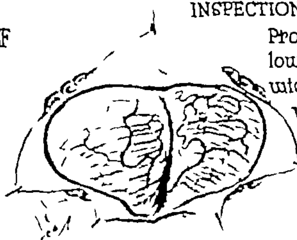
**J** Inspection of superior margin of the left cerebellar hemisphere.

**K** Needle may be inserted for possible detection of tumor in either hemisphere.

*(Continued on Plates 145 to 147)*

INSPECTION

F



Prominent hemisphere, low cerebellar tonsil, and widened cerebellar convolutions may indicate side in which tumor is located

G



Check right cerebello-pontine angle

H



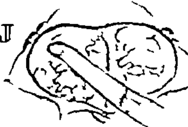
Check left cerebello-pontine angle

I



Check superior surface of right cerebellar hemisphere

J



Check superior surface of left cerebellar hemisphere

K



Needle both hemispheres

Plate 144

**L** Tonsilla separated, exposing the foramen of Magendie.

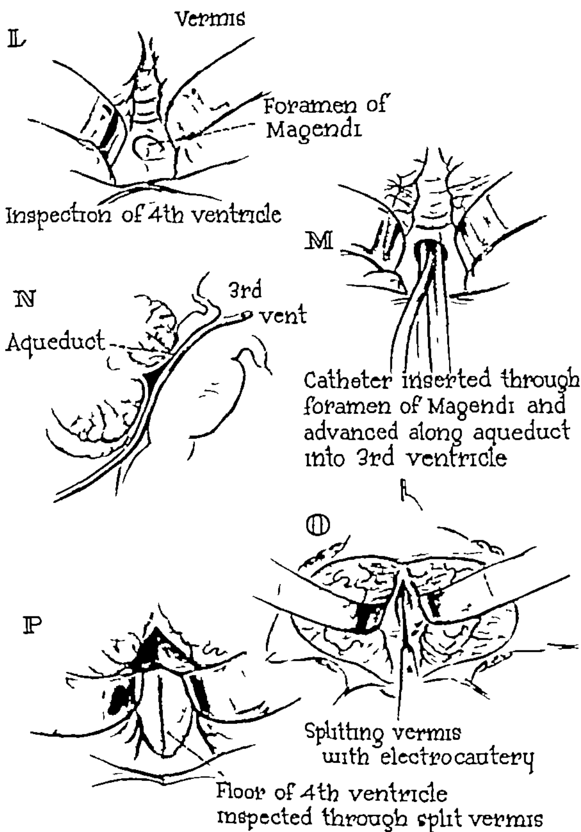
**M** Catheter inserted through the foramen of Magendie into the fourth and third ventricles for possible obstruction

**N** Catheter in place.

**O** If the vermis is slightly widened it may be necessary to incise it sagittally

**P** This allows thorough inspection of the fourth ventricle.

*(Continued on Plates 146 and 147)*


L
Vermis
Foramen of Magendi
Inspection of 4th ventricle
M
Catheter inserted through foramen of Magendi and advanced along aqueduct into 3rd ventricle
N
3rd vent
Aqueduct
O
Splitting vermis with electrocautery
P
Floor of 4th ventricle inspected through split vermis

**Q** Line of incision in dura, avoiding the occipital sinus.

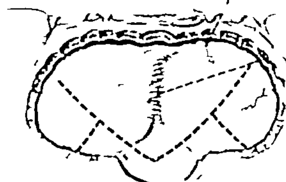
**R** Exposure of both cerebellar hemispheres obtained by the type of incision used.

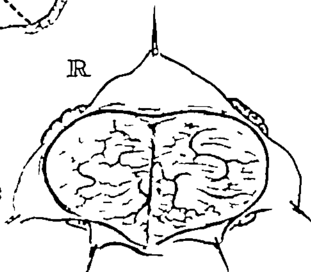
**S** Closure of the dura.

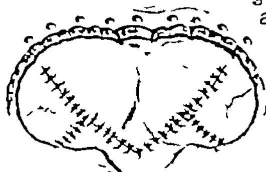
**T** Small burr openings made to attach the muscle with stainless steel wire sutures, if indicated.

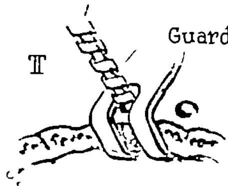
This is rarely necessary and a single layer of stainless steel wire sutures closing the scalp is usually sufficient. When this is done the dura must be left widely open, or if closed, no pinpoint openings must be present between the interrupted silk sutures in the dura. Permanent pseudoarachnoid cysts will not occur if the dura is either left widely open or closed watertight.

*(Continued on Plate 147)*


Q
Lateral sinus
Occipital sinus
Lines of dural incision


R
Dural flaps retracted with sutures


S
Holes drilled through bone for attaching muscle
Dura closed


T
Electric drill
Guard

**U** Closure by attaching muscle to bone with stainless steel wire.

**V** The scalp may be closed with two interrupted layers of black silk or with a single layer of end-on stainless steel mattress sutures.

**W** Type of dressing used.

**X** Dressing in place

Plate 147

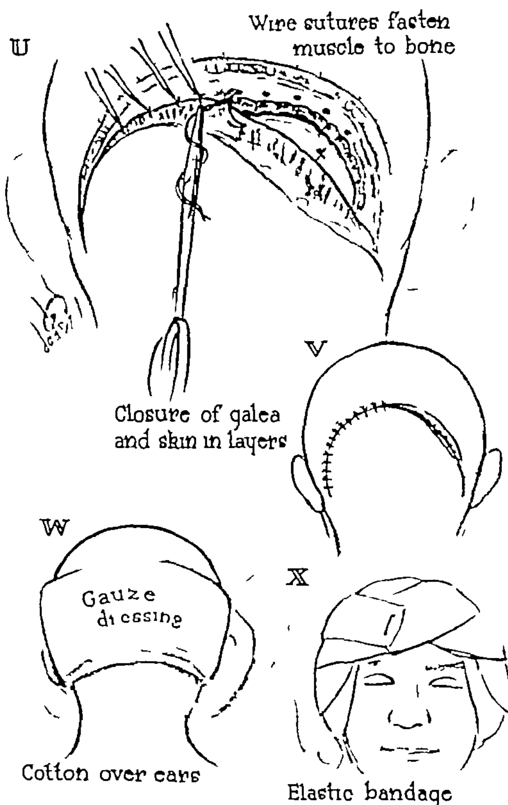

U
Wire sutures fasten
muscle to bone
Closure of galea
and skin in layers
V
W
Gauze
dressing
Cotton over ears
X
Elastic bandage

Plate 147

# PARASAGITTAL CRANIAL EXPLORATION TREPHINE PROCEDURE

At times it is difficult to ascertain from air studies or arteriograms whether a tumor is present and/or the type it is. This is especially true of gliomas in the region of the cingulate gyrus. A satisfactory method which allows a simple exploration through a trephine opening is illustrated. If a tumor is encountered either it may be removed through the trephine opening or the entire outlined incision can be made and a frontal bone flap turned down. If a glioma of the cingulate gyrus extends into the corpus callosum surgery beyond that which can be completed through the trephine opening is superfluous.

A Question mark incision outlined dark line indicates initial incision Trephine marking.

B Location of initial scalp incision Trephine button removed in relationship to sagittal sinus.

C Dural opening.

D Pedicle of dura next to sagittal sinus.

E Coronal section through area of tumor

*Inset* Operative view

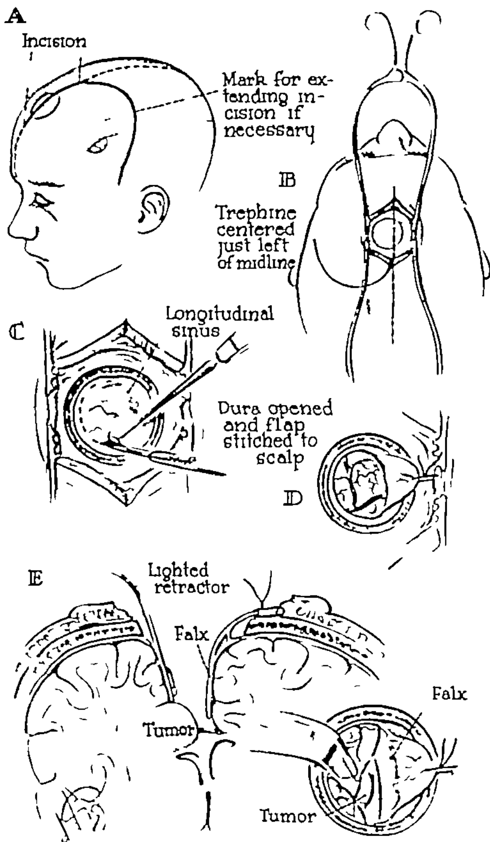

A
Incision
Mark for extending incision if necessary
B
Trephine centered just left of midline
C
Longitudinal sinus
Dura opened and flap stitched to scalp
D
E
Lighted retractor
Falx
Tumor
Falx
Tumor

Plate 148

# Part II NECK

# Part II NECK

**A** Carotid bifurcation dissected well above and below area of atheromatous plaque superior thyroid artery ligated The line of incision lies immediately over the atheromatous plaque and is extended above and below the plaque. Temporary clamps are placed on the common and external carotid arteries

**B** Dissection of the intima involved with the atheromatous changes intima removed above and below the extension of the plaque and then excised.

**C** Plaque removed.

**D** When a soft clot is present, suction tip is inserted into the internal carotid artery for removal

Blood is allowed to flow retrograde from the internal carotid artery to wash out fragments and air

**E** Internal carotid irrigated with saline to remove all loose fragments and clot.

**F** Incision closed with interrupted black silk suture.

Gelfoam is placed over the line of suture and mild pressure is exerted over the line of incision while the clamps are removed from the common and external carotid arteries.

The carotid sinus is removed as demonstrated in the operation for Irritable Carotid Sinus (Plate 152)

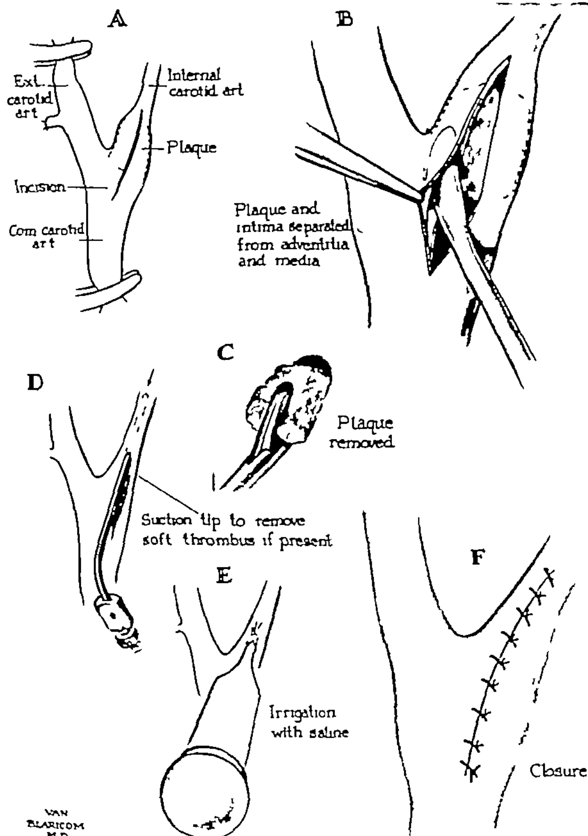

A
Ext. carotid art
Internal carotid art
Plaque
Incision
Com carotid art
B
Plaque and intima separated from adventitia and media
C
Plaque removed
D
Suction tip to remove soft thrombus if present
E
Irrigation with saline
F
Closure
VAN BLARICOM M D

Plate 149

# IRRITABLE CAROTID SINUS PERIARTERIAL STRIPPING OF CAROTID BULB

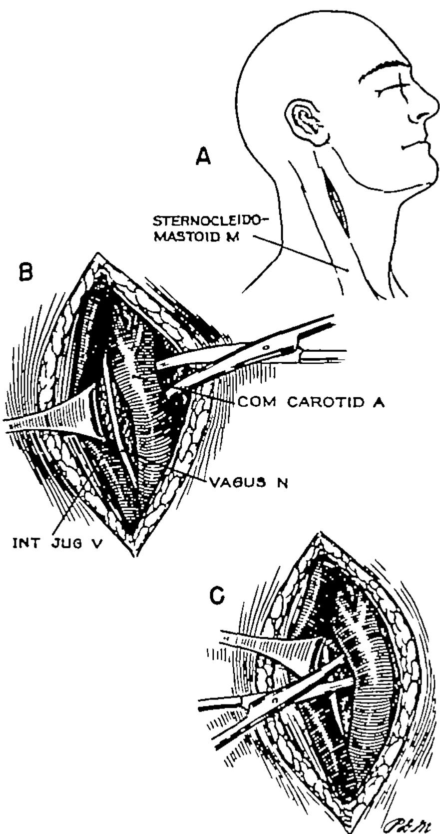
**A** *Line of incision anterior to sternocleidomastoid muscle.*

**B** Dissection of the common carotid artery

**C** Separation of the common carotid artery from the vagus, as well as from the carotid bulb

*(Continued on Plates 151 and 152)*

# IRRITABLE CAROTID SINUS PERIARTERIAL STRIPPING OF CAROTID BULB



# IRRITABLE CAROTID SINUS PERIARTERIAL STRIPPING OF CAROTID BULB

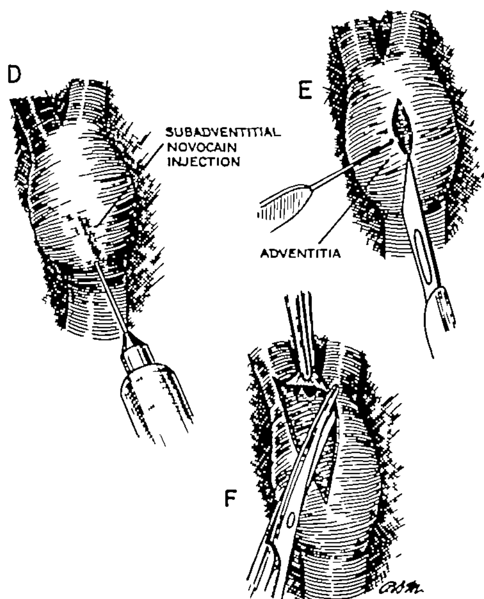
**D** Procaine solution inserted immediately beneath the adventitia, separating it from the media

**E** While the adventitia is ballooned from the media by the procaine solution a dural hook is inserted into the adventitia and incision made.

**F** Wedge-shaped area of adventitia removed from the common, internal and external carotid arteries.

*(Continued on Plate 152)*

# IRRITABLE CAROTID SINUS PERIARTERIAL STRIPPING OF CAROTID BULB



# IRRITABLE CAROTID SINUS PERIARTERIAL STRIPPING OF CAROTID BULB

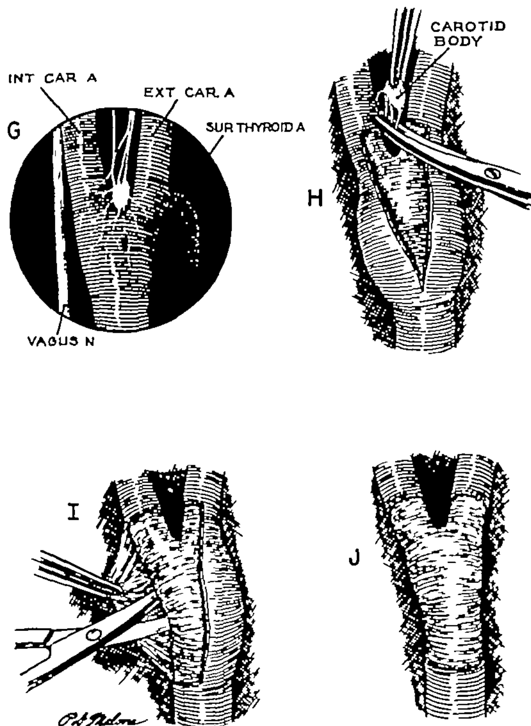
G Anatomy at the bifurcation of the common carotid artery i.e., the carotid body with its sympathetic branches.

H Resection of the carotid body

I Adventitia separated from the media by blunt dissection with Metzenbaum scissors.

J Complete denervation of the common carotid artery and the proximal ends of the internal and external carotid arteries.

# IRRITABLE CAROTID SINUS PERIARTERIAL STRIPPING OF CAROTID BULB



# INTRACRANIAL ANEURYSM LIGATION OF THE CAROTID ARTERY IN THE NECK

*Temporary Application of Carotid Clamp*

An oblique cervical incision is made along the anterior surface of the sternocleidomastoid muscle sufficiently high to provide adequate exposure of the bifurcation and internal carotid artery

**A** *Two loops of heavy black silk are placed around the internal carotid artery approximately 1 cm. apart.*

**B** Clamp is then placed between the two loops of black silk, close to a point where the internal carotid artery is completely occluded.

Care must be taken not to crush the intima.

**C** After careful placement of the clamp, a reading is taken on the clamp scale which has been calibrated in 1 mm. marks.

By this means the degree of closure of the lumina of the artery can be determined, in case the clamp must be opened at a later date.

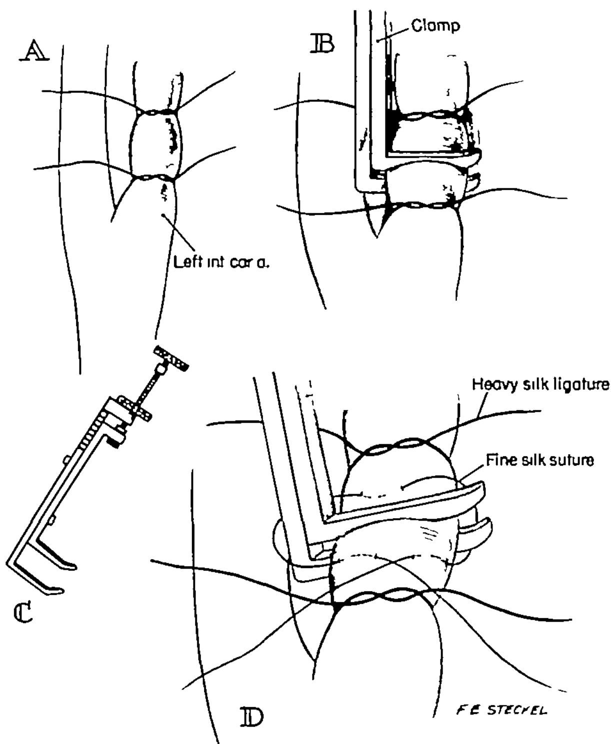
**D** Artery completely occluded by the clamp A loop of fine silk is placed around the clamp as indicated, to prevent dislocation of the clamp if it is necessary to open it during the trial closure of the artery

At the present time the clamp is applied under general anesthesia. The clamp is left *open until the patient is conscious at that time it is closed completely*

During the first twenty-four hours after application of the clamp, the patient is watched constantly motor power speech, mental state pulse and blood pressure must be checked every twenty minutes. The nurse must be fully instructed on the procedure of immediately opening the clamp should this become necessary *Close surveillance is maintained for at least three days. If the patient has* not tolerated complete occlusion, very gradual occlusion is attempted before closing the clamp 1 mm. each day If even gradual occlusion is not tolerated, the clamp and the suture material are removed.

If occlusion has been well tolerated and no further procedures are contemplated, *small reopenings* are made above and below the clamp Black silk sutures are tied above and below the clamp and the clamp is removed.

If a trapping procedure is to be carried out, permanent ligation of the carotid artery in the neck is performed under the same anesthesia but is not completed until the intracranial portion of the carotid artery is occluded. This lessens the danger of embolus.


A
B
Clamp
Left int car a.
C
D
Heavy silk ligature
Fine silk suture
F E STECKEL

A The incision is made over the anterior edge of the sternocleidomastoid muscle, extending from above the mastoid downward for a distance of approximately 11 to 12.5 cm.

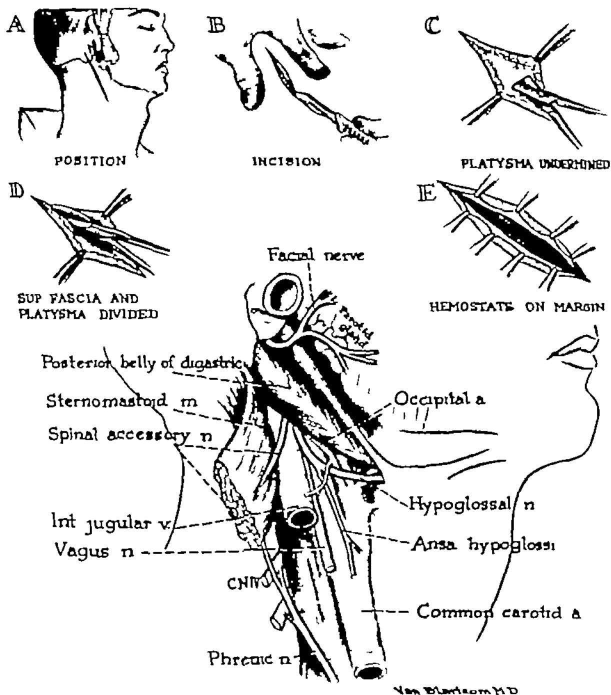
B The incision is made to the depth of the deep fascia and platysma muscle.

C Platysma muscle is undermined with Metzenbaum scissors.

D The fascia and platysma are divided.

E Hemostats are placed on the edge of the platysma and fascia, uncovering the fascia over the sternocleidomastoid muscle. In the central sketch, the relationship of the various structures is shown for orientation.

*(Continued on Plates 155 to 158)*


A
POSITION
B
INCISION
C
PLATYSMA UNDERMINED
D
SUP FASCIA AND
PLATYSMA DIVIDED
E
HEMOSTATS ON MARGIN
Facial nerve
Posterior belly of digastric
Sternomastoid m
Spinal accessory n
Occipital a
Hypoglossal n
Int jugular v
Vagus n
Ansa hypoglossi
CN IV
Common carotid a
Phrenic n

**A** The incision is made over the anterior edge of the sternocleidomastoid muscle, extending from above the mastoid downward for a distance of approximately 11 to 12.5 cm.

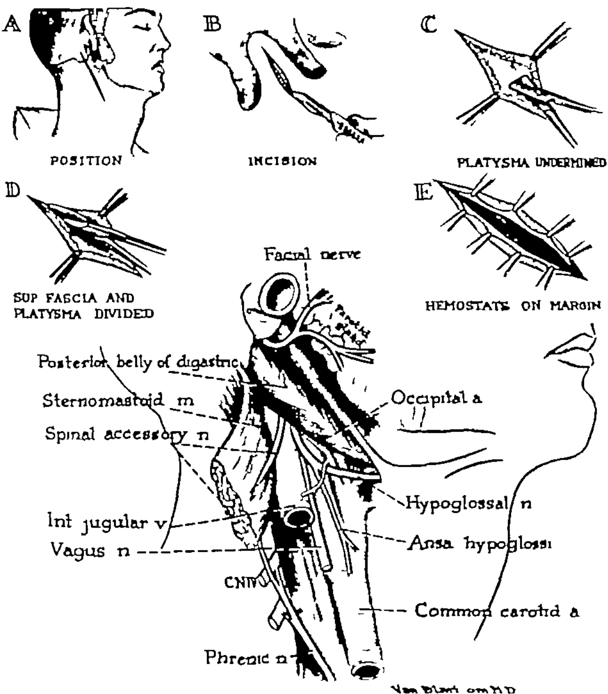
**B** The incision is made to the depth of the deep fascia and platysma muscle.

**C** Platysma muscle is undermined with Metzenbaum scissors.

**D** The fascia and platysma are divided.

**E** Hemostats are placed on the edge of the platysma and fascia, uncovering the fascia over the sternocleidomastoid muscle. In the central sketch the relationship of the various structures is shown for orientation

*(Continued on Plates 155 to 158)*


A
B
C
POSITION
INCISION
PLATYSMA UNDERMINED
D
E
SUP FASCIA AND PLATYSMA DIVIDED
HEMOSTATS ON MARGIN
Facial nerve
Posterior belly of digastric
Sternomastoid m
Spinal accessory n
Occipital a
Hypoglossal n
Int jugular v
Vagus n
Ansa hypoglossi
CNIV
Common carotid a
Phrenic n

**F** The sternocleidomastoid muscle is retracted and the cervical fascia opened over the posterior belly of the digastric.

**G** The inferior portion of the parotid and the posterior belly of the digastric are exposed.

**H** Dissection is carried medially over the tendinous portion of the digastric muscle. Immediately underneath, the hypoglossal nerve can be readily exposed.

**I** The descendens hypoglossi fibers are separated from the main trunk of the hypoglossal nerve, *as indicated by the dotted line. This tends to provide a longer segment of the hypo-*glossal nerve for mobilization

**J** The hypoglossal nerve is divided at the point where it starts to branch A tongue depressor is placed immediately beneath the trunk of the nerve so that a clean section can be made with a sharp knife.

*(Continued on Plates 156 to 158)*

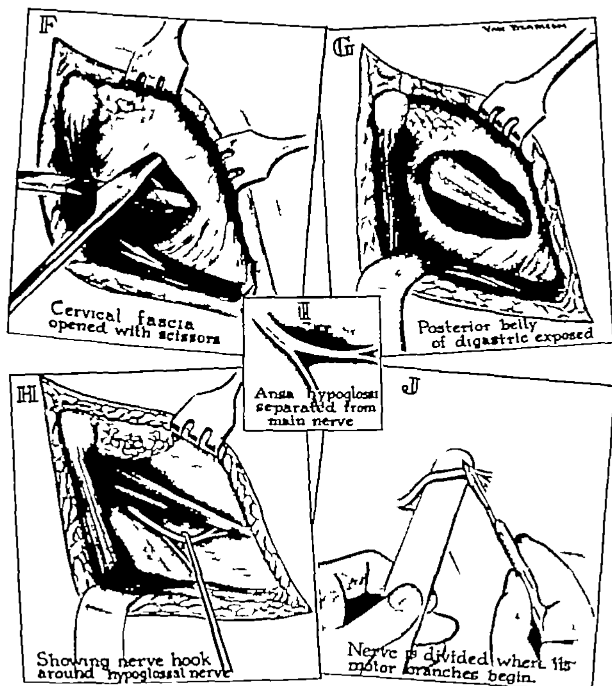

F
Cervical fascia opened with scissors
G
Posterior belly of digastric exposed
II
Ansa hypoglossi separated from main nerve
H
Showing nerve hook around hypoglossal nerve
J
Nerve is divided where its motor branches begin.

Plate 155

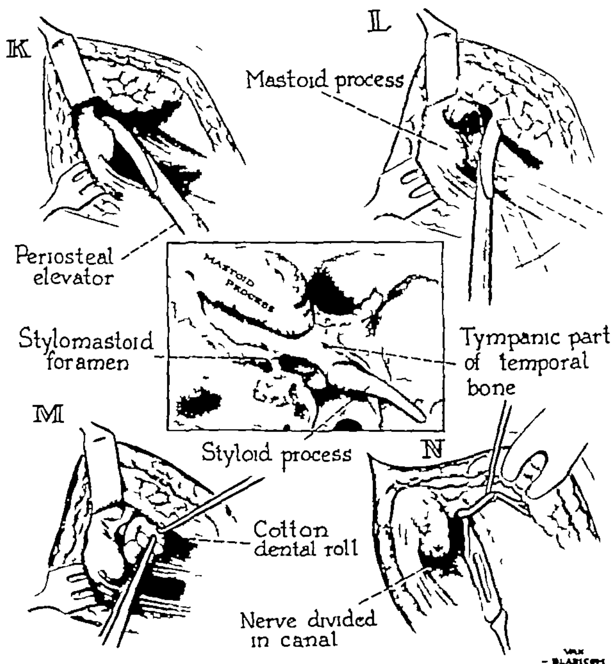
K The digastric muscle is separated with a periosteal elevator from the fascia overlying the mastoid process.

L The soft tissues can be separated from the tympanic part of the temporal bone with the periosteal elevator

M By means of a small, firmly rolled cotton pledget, the soft tissues, including the parotid gland, are pushed upward and medially thus exposing the facial nerve.

N *The facial nerve is divided at the stylomastoid foramen. The nerve hook is allowed to remain* around the nerve trunk as the tongue of the parotid gland is elevated upward and medially with a cotton dental roll, exposing the distal cut end of the facial nerve. The central anatomical drawing demonstrates the relationship of the stylomastoid foramen to the tympanic part of the temporal bone and the styloid process

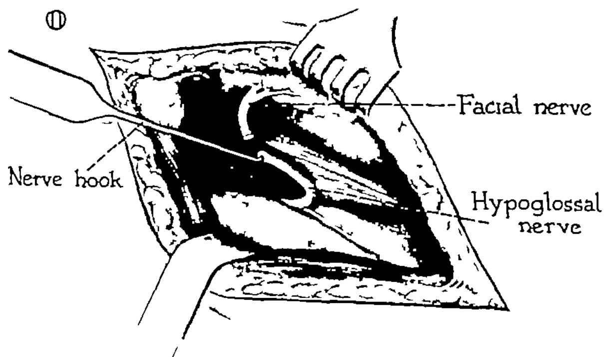
*(Continued on Plates 157 and 158)*

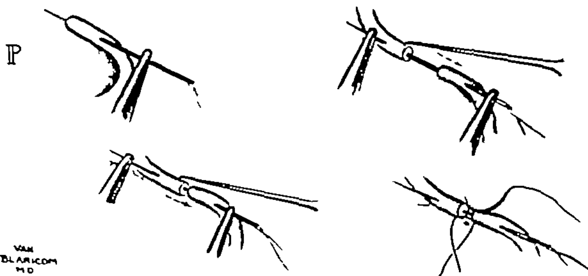

K
L
M
N
Mastoid process
Periosteal elevator
Mastoid process
Stylomastoid foramen
Tympanic part of temporal bone
Styloid process
Cotton dental roll
Nerve divided in canal

**O** *The proximal end of the hypoglossal nerve is brought in contact with the distal end of the* facial nerve over the posterior belly of the digastric.

**P** A fine arterial needle is inserted through the central portion of each end of the nerve trunks and the neural sheath is sutured with fine, interrupted black silk arterial sutures. Care must be taken that the nerve ends are not angulated.

*(Continued on Plate 158)*

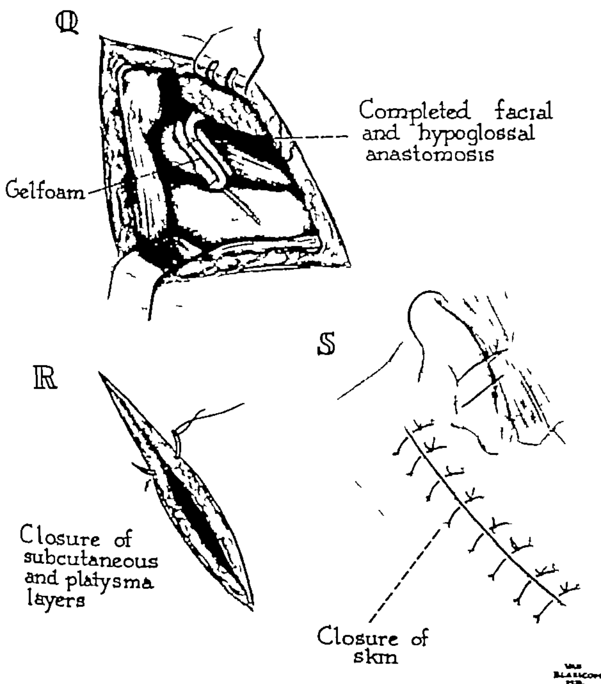

O
Facial nerve
Nerve hook
Hypoglossal nerve


P
VAN BLARICOM MD

**Q** The hypoglossofacial anastomosis has been completed. Gelfoam is placed around the line of suture.

**R** Closure of subcutaneous and platysma layers.

**S** Skin closure.


Q
Completed facial and hypoglossal anastomosis
Gelfoam
R
Closure of subcutaneous and platysma layers
S
Closure of skin

# FACIAL PARALYSIS SPINAL ACCESSORY-FACIAL AND PHRENICOFACIAL ANASTOMOSIS

*I Spinal Accessory–Facial Anastomosis*

**A**
**B** Anatomical relationships and completion of anastomosis of the spinal accessory and facial nerves.

*II Phrenicofacial Anastomosis*

**C** The two lines of incision employed are shown

**D** The phrenic nerve is divided over the lower end of the anterior scalenus muscle.

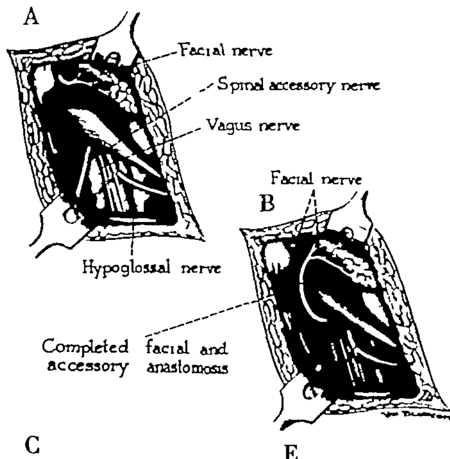
**E** The proximal end of the phrenic nerve is brought underneath the sternocleidomastoid muscle into the field of the upper incision and the anastomosis made as in the hypoglossal anastomosis.

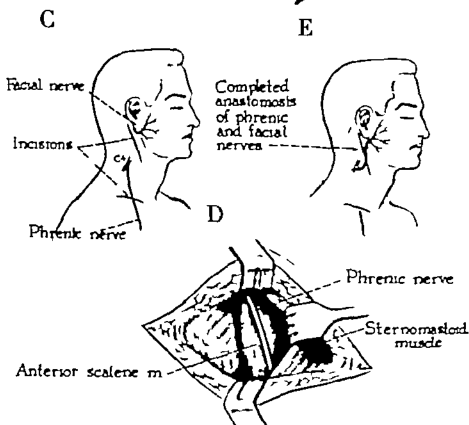
A combination of a fifth seventh and twelfth cranial nerve paralysis results in drooling and difficulty in mastication. In these patients therefore with a complete fifth and seventh cranial nerve paralysis, either the spinal accessory–facial or phrenicofacial nerve anastomosis is preferable.

In patients whose livelihood depends on singing, elocution and the like, the hypoglossal nerve should not be used. In right-handed patients who have special muscular requirements, for example a symphony orchestra leader *if the anastomosis is to be done on the right side, the spinal accessory* nerve should not be used—the hypoglossal nerve is preferable.

If bilateral facial nerve paralysis is present, a bilateral hypoglossofacial anastomosis cannot be performed. In such cases the hypoglossofacial anastomosis may be used on one side and a phrenicofacial or spinofacial anastomosis on the opposite side.

## FACIAL PARALYSIS SPINAL ACCESSORY-FACIAL AND PHRENICOFACIAL ANASTOMOSIS



Support to the face is desirable for patients with facial paralysis when facial tone is expected to return within three months following necessary hypoglossofacial, spinal accessory–facial or phrenicofacial anastomosis

A Two 1 cm. incisions are made, one at the angle of the mouth and the second over and above the anterior portion of the zygoma.

B The index finger is inserted into the mouth. A long needle with a stainless steel wire attached is inserted through the zygomatic opening and placed in the tissues as centrally as possible The needle emerges from the small incision at the angle of the mouth and is then reinserted through this incision.

C The needle emerges through the small incision over the zygoma.

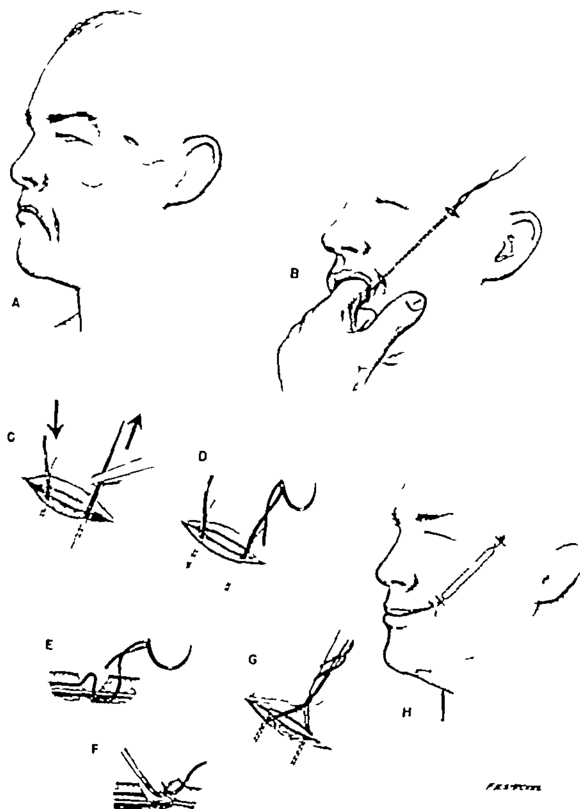
D Since it is sometimes difficult to insert the needle through the temporal fascia because of the small incision, a cutting needle is attached to one end of the wire.

E The needle has been brought through the depth of the fascia and through the skin above the incision

F A nerve hook is then inserted underneath the skin to pull the distal end of the wire back through the incision.

G Wire twisted to obtain the desired length of the sling excess wire cut.

H *Loop in place. The angle of the mouth has been drawn up to a considerable degree,* producing a sardonic expression. This is apparent for only a week or ten days, when some relaxation of the angle of the mouth again occurs. The small skin incisions are closed with a single interrupted black silk suture.


A
B
C
D
E
F
G
H

**A** Position of patient.

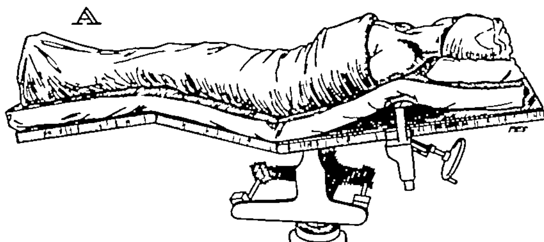
**B** Location of incision relation of incision to clavicle.

Incision should be placed approximately 3 cm. above the clavicle, especially if the patient s head is slightly extended this prevents the incision from falling over the clavicle with head in normal position

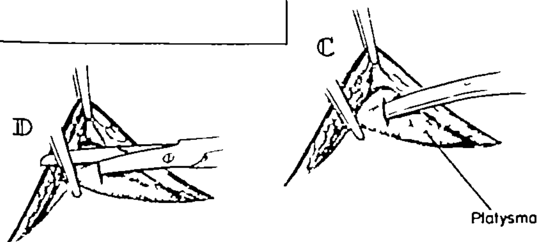
**C** Platysma muscle separated from underlying tissues by blunt dissection with scissors.

**D** Platysma muscle then divided, thus exposing the clavicular portion of the sternocleidomastoid muscle.

*(Continued on Plates 162 and 163)*


A


B
Incision


C
D
Platysma

**E** Section of the clavicular portion of the sternocleidomastoid muscle.

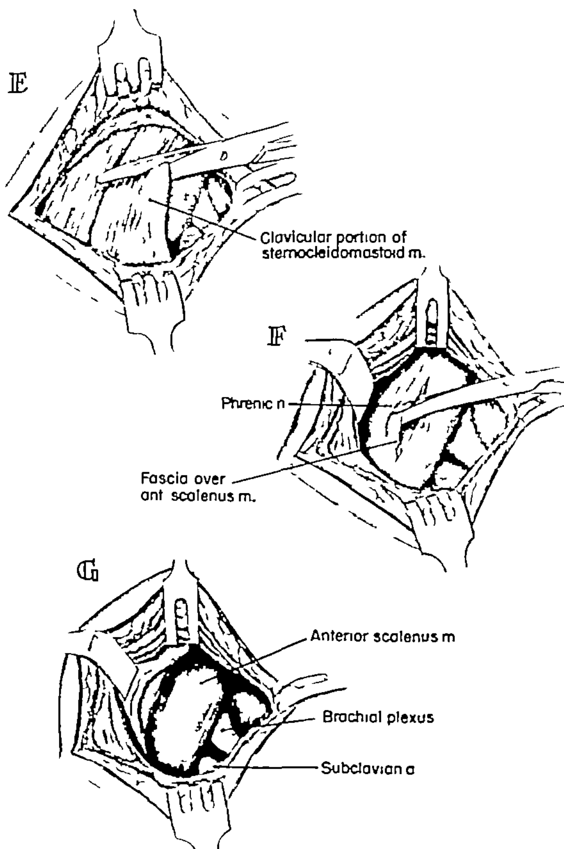
The anterior scalenus muscle can be palpated by inserting a finger to the depth of the incision. This muscle is easily identified by its characteristic contour and it gives a sensation similar to palpating the palmar surface of a thumb.

**F** Fascia over the anterior scalenus muscle incised

**G** Phrenic nerve freed from the muscle incorporated in the fascia and retracted medially

At times the phrenic nerve divides into two branches and care must be taken not to divide the accessory branch When the anterior scalenus muscle is divided on the left side, it is important in this operation to retract medially the fatty tissue lying above the anterior scalenus muscle, to prevent injury to the thoracic duct. If a larger channel of the thoracic duct is divided, the ends should be occluded to prevent future collection of lymph in the operative site.

*(Continued on Plate 163)*


E
Clavicular portion of
sternocleidomastoid m.
F
Phrenic n
Fascia over
ant scalenus m.
G
Anterior scalenus m
Brachial plexus
Subclavian a

**H** Method of incising the anterior scalenus muscle. Bundles of muscle can be readily elevated with a vein retractor and divided with scissors.

**I** *Muscle to be removed, 4 or 5 cm in length*

As the muscle fibers are divided cephalad, a corresponding portion of the muscle attached to the first rib should be divided. This prevents retraction of the muscle bundle as a whole, which occurs if the muscle is divided entirely in the upper portion without simultaneous incision in the lower portion.

**J** Anterior scalenus muscle divided and removed

Fascia of the muscle over the subclavian artery is then divided and the subclavian artery can be freed for adequate decompression. If indicated, the upper branches of the thoracic sympathetic chain are removed as demonstrated in Resection of Cervical Rib and Cervical Sympathectomy (Plate 169)

**K** Small Penrose drain. Closure of skin as in Resection of Cervical Rib.

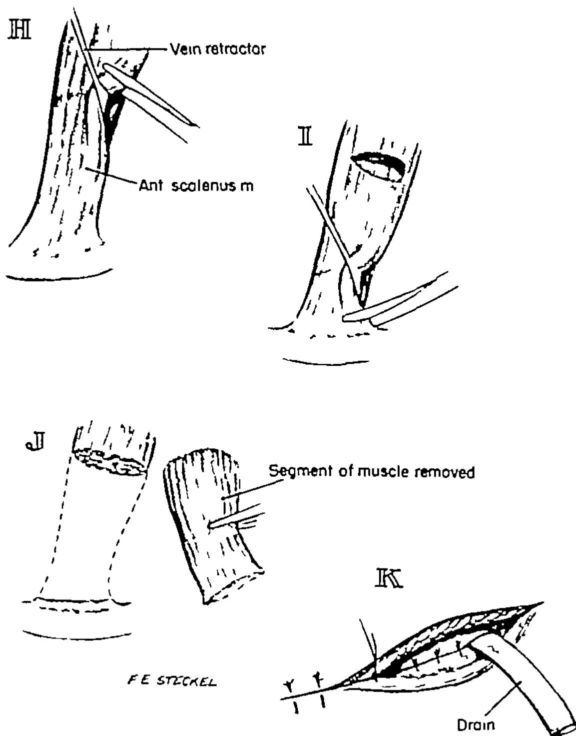

H
Vein retractor
Ant scalenus m
I
J
Segment of muscle removed
K
F E STECKEL
Drain

Plate 163

H Method of incising the anterior scalenus muscle. Bundles of muscle can be readily el
with a vein retractor and divided with scissors.

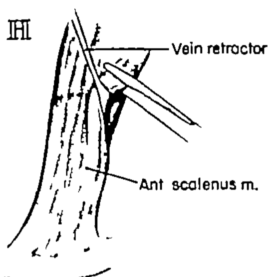
I Muscle to be removed 4 or 5 cm. in length.

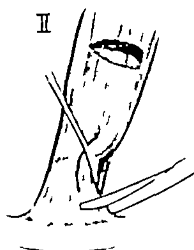
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whole which occurs if the muscle is divided entirely in the upper portion w
simultaneous incision in the lower portion

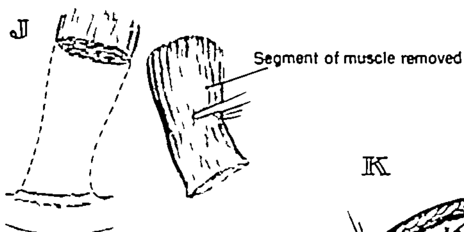
J Anterior scalenus muscle divided and removed.

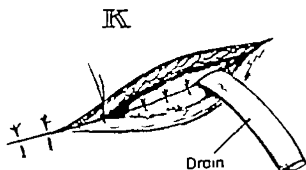
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sympathetic chain are removed as demonstrated in Resection of Cervical Rit
Cervical Sympathectomy (Plate 169)

K Small Penrose drain. Closure of skin as in Resection of Cervical Rib


H
Vein retractor
Ant scalenus m.


I


J
Segment of muscle removed
F E STECKEL


K
Drain

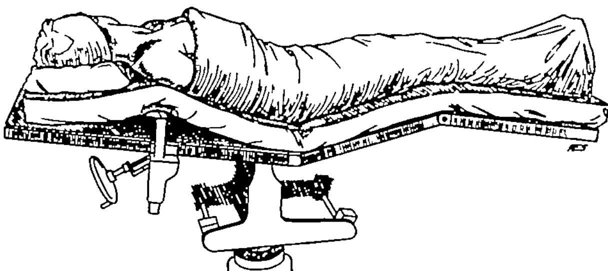
A Position of patient.

B Incision.

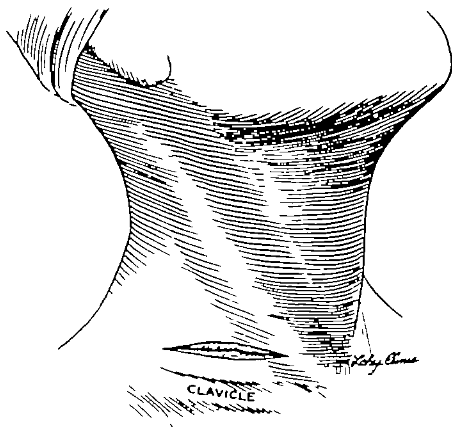
Refer to the operative technique in Anterior Scaleniotomy for the exposure and resection of the anterior scalenus muscle.

*(Continued on Plates 165 to 169)*

A



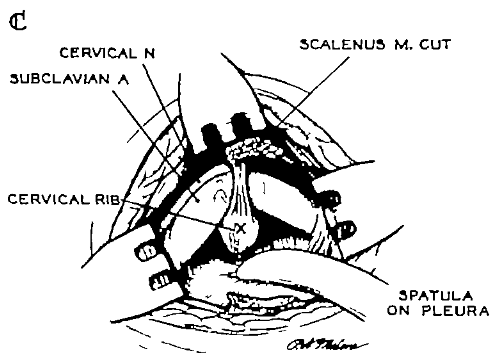
B



**C** Relationship of the cervical rib to the artery and the lower group of nerves of the brachial plexus.

Removal of the cervical rib is simplified by mobilizing the parietal pleura by incising the Sibson's fascia

(*Continued on Plates 166 to 169*)


C
CERVICAL N
SUBCLAVIAN A
SCALENUS M. CUT
CERVICAL RIB
SPATULA
ON PLEURA

**D** Incision of fascia and ligament over tip of cervical rib

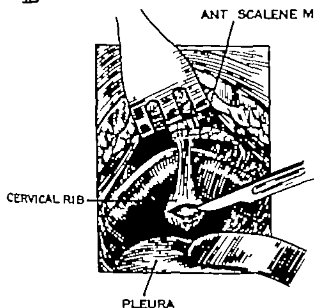
**E** Ligament excised. Soft tissues removed from the rib with periosteal elevator Pleura over apex of lung depressed

**F** Rib removed piecemeal with rongeur

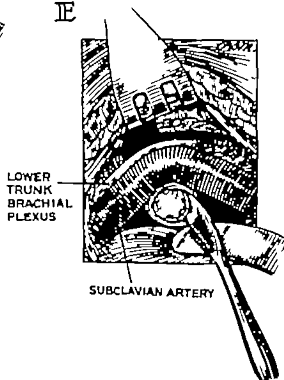
After the lower portion of the rib has been removed nerve trunks of the brachial plexus can be separated and the rib can be completely removed from the transverse process. The periosteum should be removed with the rib This procedure usually prevents regeneration.

*(Continued on Plates 167 to 169)*

D




E




F

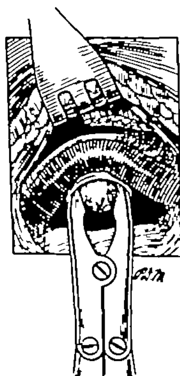
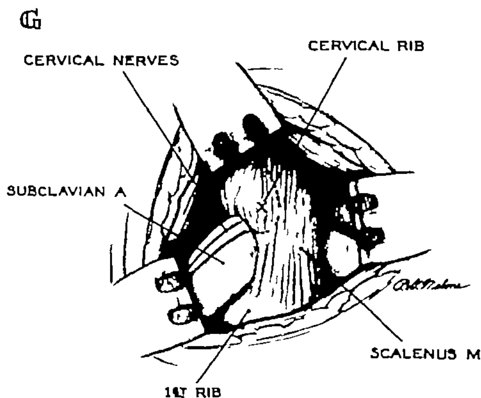


Plate 166

**G** Artery below point of rib relationship of artery to muscle and brachial plexus

*(Continued on Plates 168 and 169)*


G
CERVICAL RIB
CERVICAL NERVES
SUBCLAVIAN A
SCALENUS M
1ST RIB

**H** Relationship of rib to artery and brachial plexus.

**I** Inferior portion of the brachial plexus elevated with light retraction and subclavian artery depressed, thus allowing complete removal of the rib

(*Continued on Plate 169*)

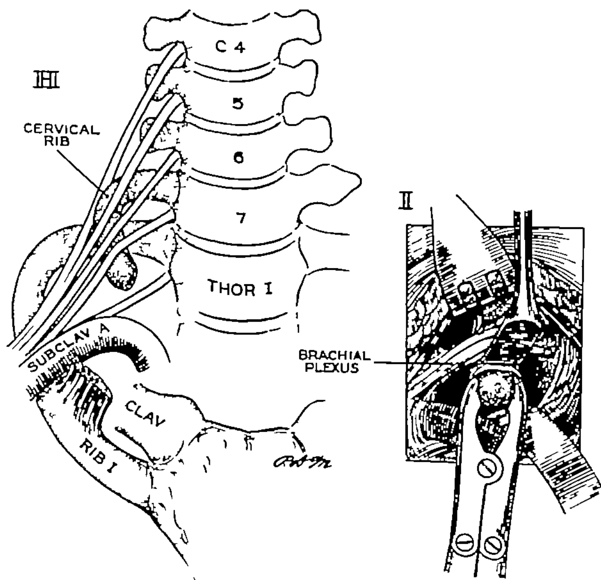

III
CERVICAL RIB
C 4
5
6
7
THOR I
SUBCLAV A
CLAV
RIB I
II
BRACHIAL PLEXUS

Plate 168

J The upper dorsal sympathetic chain should be removed in all patients who have considerable vasomotor changes in the extremity associated with the cervical rib Usually removal of the second, third and fourth ganglia is sufficient.

*The ramus communicans can be separated from the brachial plexus, inferior cervical* ganglion and first thoracic ganglion. Care should be exercised not to place too much traction on the stellate ganglion, since a Horner s syndrome will usually develop. If this portion is carefully handled, it is possible to separate the first thoracic ganglion from the inferior cervical ganglion without producing a Horner s syndrome. Thus resection of the first second third and fourth upper thoracic ganglia is completed.

*A small Penrose catheter is allowed to remain in the cavity and the incision is closed with inter*rupted silk sutures. If black silk sutures are used, care must be taken that the subcuticular silk is sufficiently buried so that sutures will not be visible underneath the skin at a later date. For this *reason*, subcuticular tissues may be closed with fine catgut or cotton.

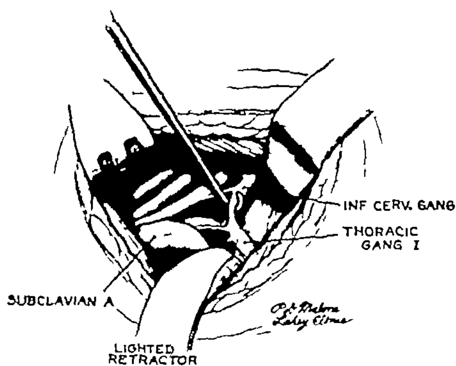

INF CERV. GANG
THORACIC
GANG I
SUBCLAVIAN A
LIGHTED
RETRACTOR

Plate 169

# BRACHIAL PLEXUS NEUROMA EXPOSURE AND REMOVAL

A Line of incision.

B Platysma muscle undermined.

C Incision of platysma muscle.

D Fascia lateral to the clavicular portion of the sternocleidomastoid muscle freed.

E Exposure of upper portion of brachial plexus. Clavicle exposed and a section removed

F Subclavian and pectoralis minor muscles divided.

G Exposure of neuroma.

H Excision of neuroma.

*(Continued on Plate 171)*

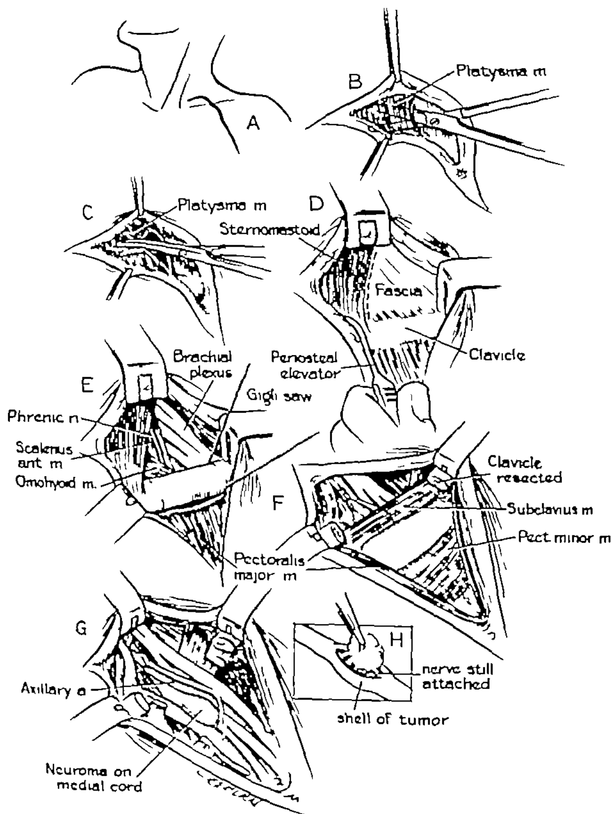

A
B
Platysma m
C
Platysma m
D
Sternomastoid
Fascia
Clavicle
Periosteal elevator
E
Brachial plexus
Gigli saw
Phrenic n
Scalenus ant m
Omohyoid m.
F
Clavicle resected
Subclavius m
Pect minor m
Pectoralis major m
G
H
nerve still attached
shell of tumor
Axillary a
Neuroma on medial cord

Plate 170

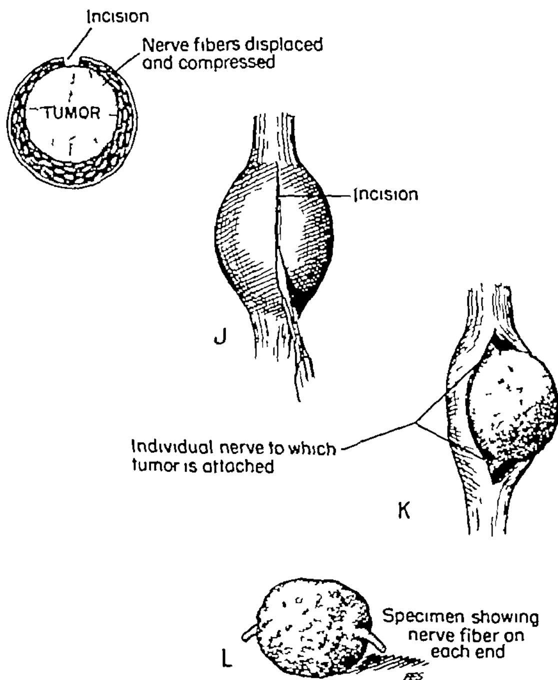
# BRACHIAL PLEXUS NEUROMA EXPOSURE AND REMOVAL

**I** Neuroma compressing the individual nerve fibers. The incision is made over the most attenuated portion.

**J** Longitudinal incision

**K** Gentle compression of the bulge made by the tumor causes the neuroma to extrude readily The individual nerve fiber to which the tumor is attached is divided cephalad and caudad.

**L** Specimen of neuroma.


Incision
Nerve fibers displaced and compressed
TUMOR
Incision
J
Individual nerve to which tumor is attached
K
L
Specimen showing nerve fiber on each end
FES

I Neuroma compressing the individual nerve fibers. The incision is made over the most attenuated portion

J Longitudinal incision.

K Gentle compression of the bulge made by the tumor causes the neuroma to extrude readily The individual nerve fiber to which the tumor is attached is divided cephalad and caudad.

L Specimen of neuroma.

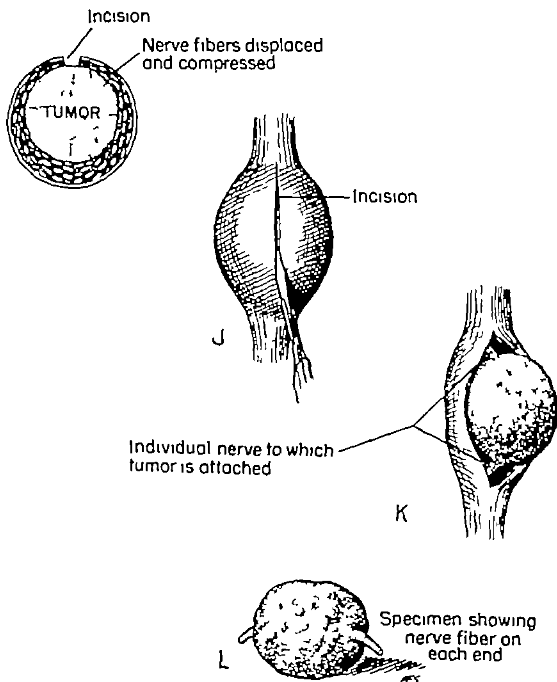

Incision
Nerve fibers displaced and compressed
TUMOR
Incision
J
Individual nerve to which tumor is attached
K
L
Specimen showing nerve fiber on each end

Plate 171

I Neuroma compressing the individual nerve fibers. The incision is made over the most attenuated portion

J Longitudinal incision.

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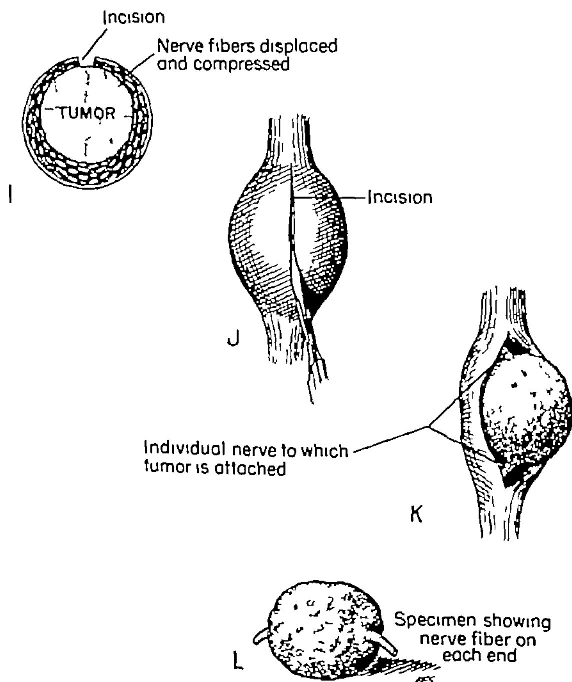

Incision
Nerve fibers displaced and compressed
TUMOR
I
Incision
J
Individual nerve to which tumor is attached
K
Specimen showing nerve fiber on each end
L

Plate 171

# SPASMODIC TORTICOLLIS ANTERIOR AND POSTERIOR CERVICAL RHIZOTOMY

**A** Line of incision in the cervical area patient in the upright position Routine laminectomy of the first, second and third cervical laminae is performed.

**B** Dentate ligaments divided to allow adequate exposure of the anterior and posterior roots.

**C** Division of the nerve roots is begun at the lower portion of the incision (i.e., at the third cervical lamina)

**D** First both the anterior and posterior roots are crushed next to the foramen intradurally

**E** The roots are divided To prevent ischemia of the upper cervical cord the larger arteries must be carefully preserved

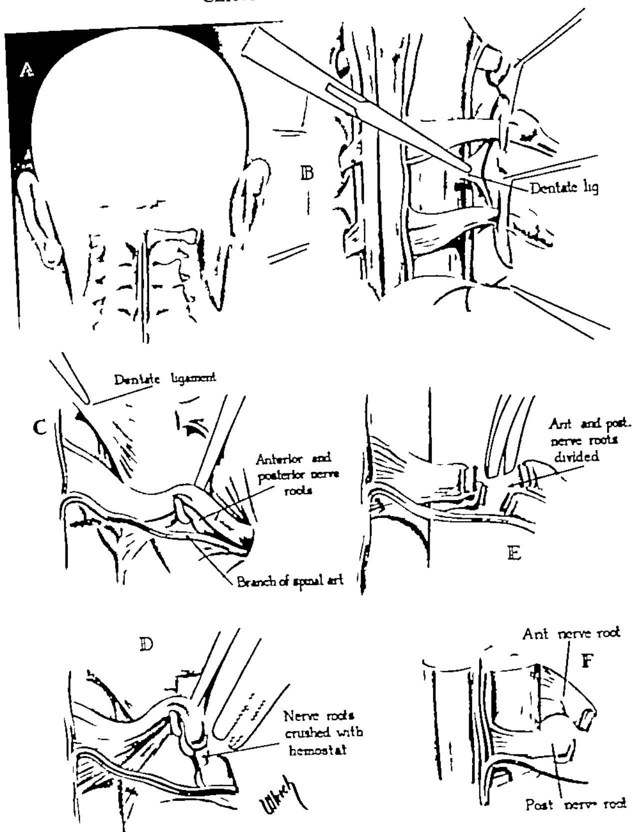
The first cervical dermatomes may have only the motor component with no sensory fibers. It is for this reason that separation of the dentate ligaments is of considerable aid.

**F** Anterior and posterior roots divided artery spared.

The spinal accessory branch may be divided on the affected side. I prefer not to section the spinal accessory nerve intraspinally

The dura is closed with interrupted black silk sutures and the soft tissues brought together with a layer of interrupted fine stainless steel sutures or black silk.

# SPASMODIC TORTICOLLIS ANTERIOR AND POSTERIOR CERVICAL RHIZOTOMY



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# SPASMODIC TORTICOLLIS ANTERIOR AND POSTERIOR CERVICAL RHIZOTOMY

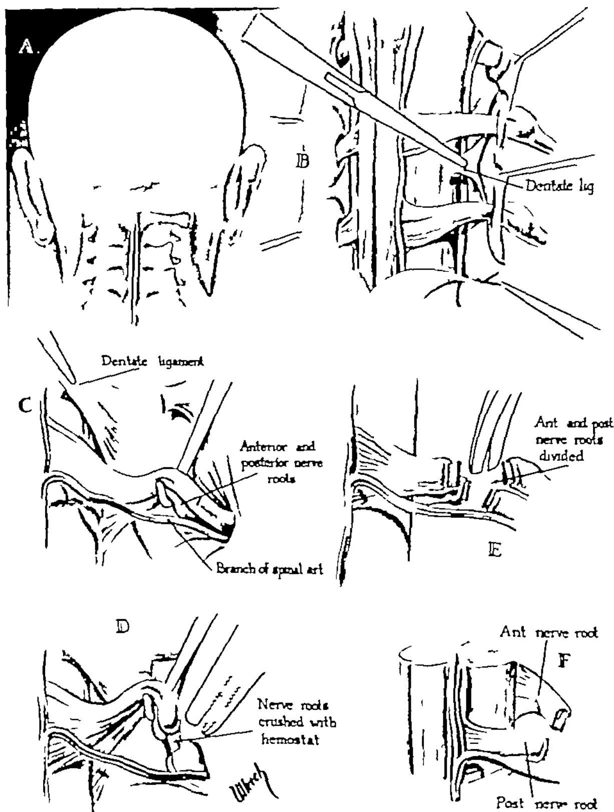



Plate 172

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SPASMODIC TORTICOLLIS ANTERIOR AND POSTERIOR CERVICAL RHIZOTOMY

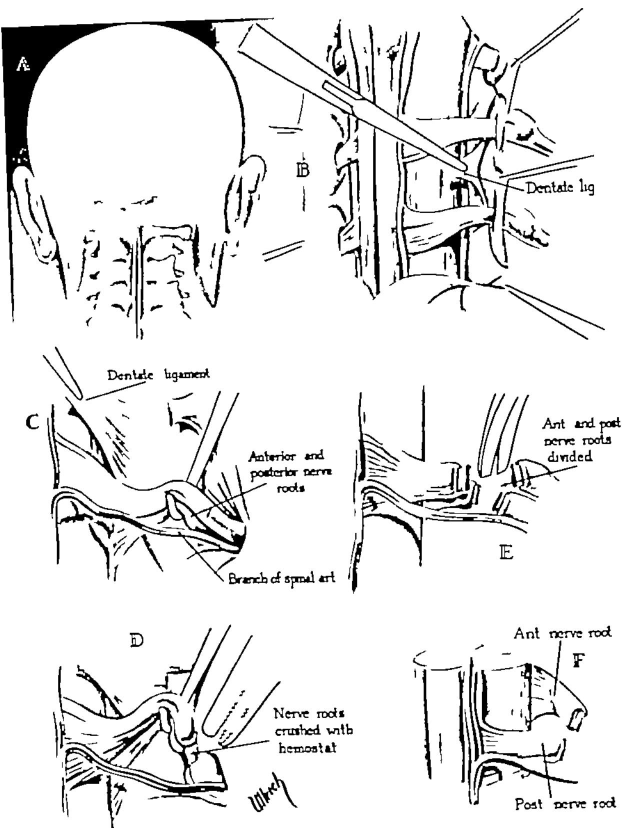



Plate 172

## SPASMODIC TORTICOLLIS SECTION OF THE STERNOCLEIDOMASTOID MUSCLE

A Incision over sternocleidomastoid muscle.

B Muscle tissue freed from fascial bed.

C Muscle divided at sternoclavicular junction.

D In this manner the main trunk of the spinal accessory nerve may be left in continuity only the branch innervating the sternocleidomastoid muscle is sacrificed

*The spinal accessory nerve occasionally penetrates the muscle in its upper third It can* be readily separated by dividing a few of the fibers of the muscle thus freeing it from its natural bed and allowing it to remain in continuity It is particularly important to save the main branch of the spinal accessory nerve to prevent a deforming wing scapula.

E Type of closure to prevent dead space.

A Penrose drain is left in place for a period of twelve to twenty-four hours. A collection of serous fluid can usually be prevented by placing the sutures as indicated, thus obliterating all dead space.

# SPASMODIC TORTICOLLIS SECTION OF THE STERNOCLEIDOMASTOID MUSCLE

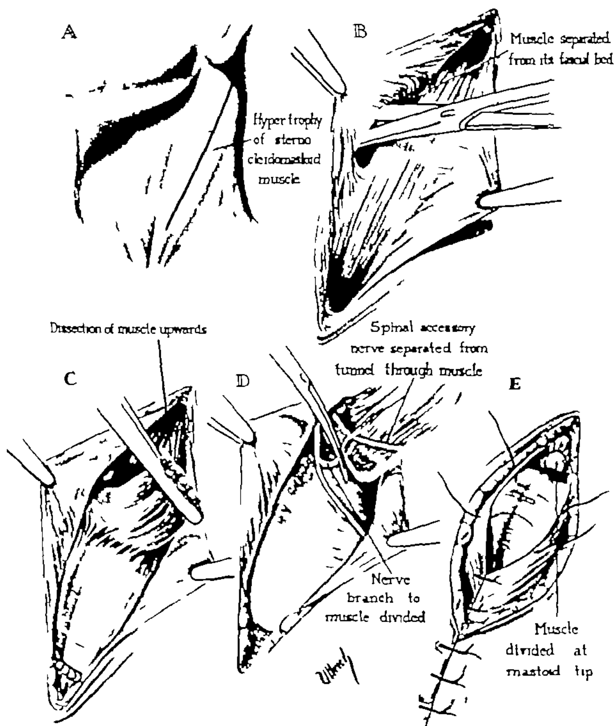



Plate 173

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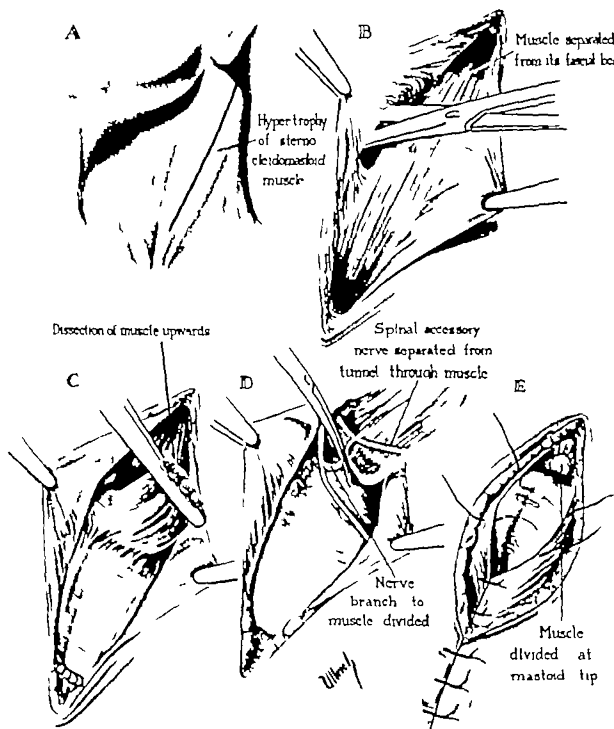



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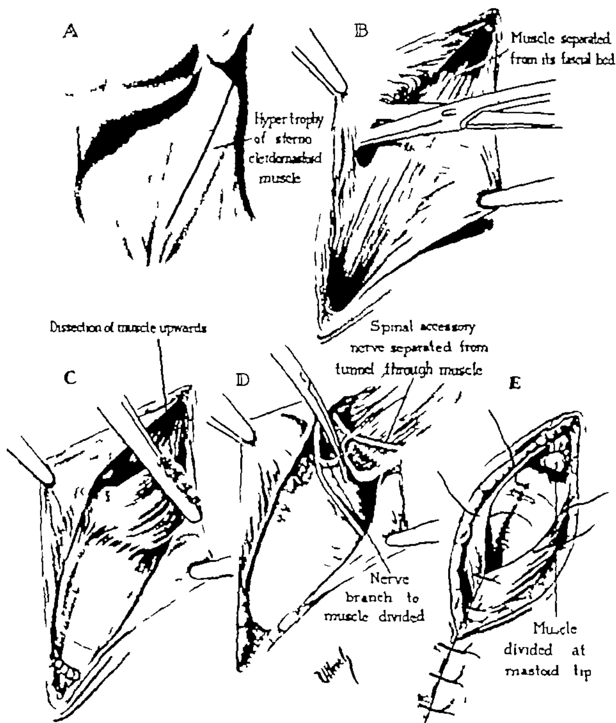



Plate 173

## SPASMODIC TORTICOLLIS SECTION OF THE STERNOCLEIDOMASTOID MUSCLE

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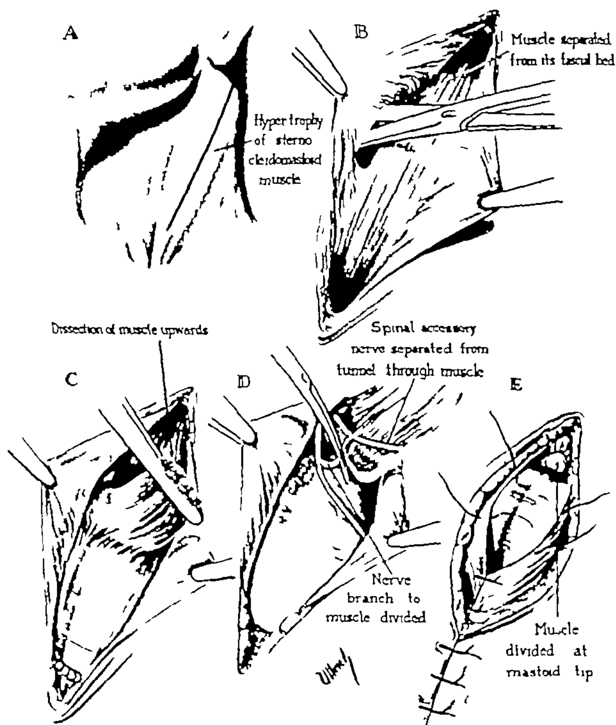



Plate 173

# Part III CHEST AND ABDOMEN

# POSTHERPETIC NEURALGIA EXCISION

**A** Segmental postherpetic neuralgia with an intensely hypersensitive area of skin involved.

**B** Line of incision.

**C** Area of skin to be excised.

**D** Affected skin removed.

**E** Edges of skin undercut cephalad and caudad.

Large areas of skin may be excised in this manner

*(Continued on Plate 175)*

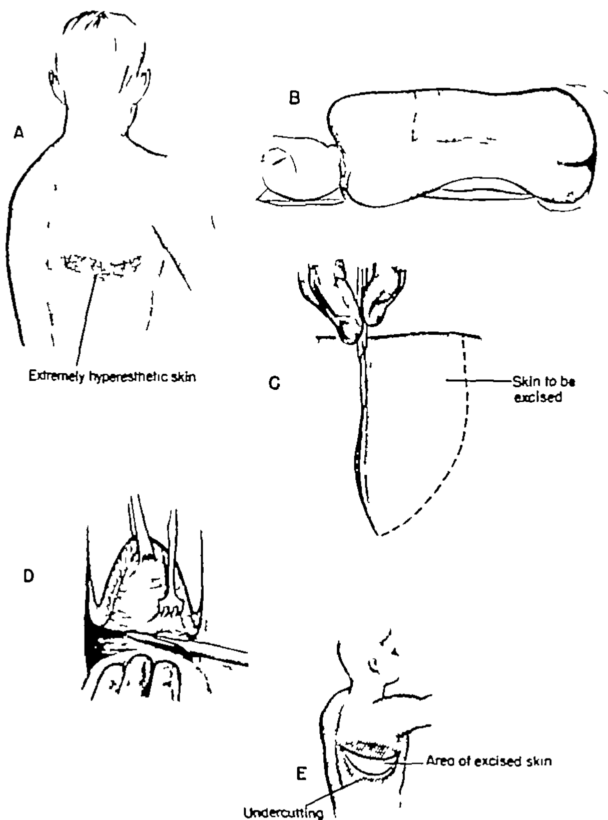
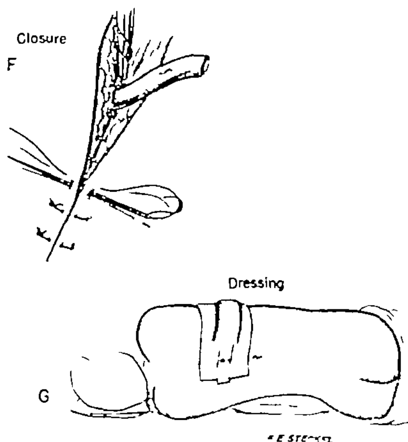

A
B
Extremely hyperesthetic skin
C
Skin to be excised
D
E
Area of excised skin
Undercutting

Plate 174

**F** Skin edges brought together with interrupted end-on mattress sutures of stainless steel wire small drain inserted for a period of twenty four hours.

**G** Dressing.


Closure
F
Dressing
G

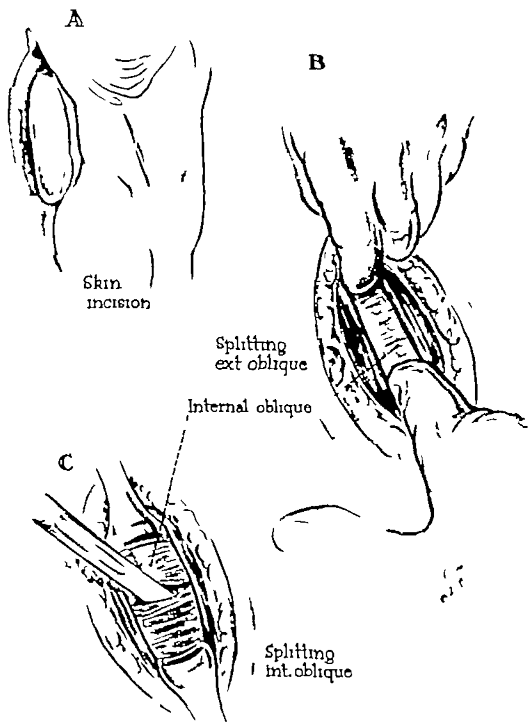
# LUMBAR SYMPATHECTOMY

A Skin incision is made to correspond approximately to the course of the muscle fibers of the external oblique, 10 to 12 cm. in length the incision extends from the tip of the tenth rib

B Fibers of the external oblique muscle are split and kept separated with a small saddle retractor

C Internal oblique muscles are then separated

*(Continued on Plates 177 to 180)*


A
B
Skin
incision
Splitting
ext oblique
Internal oblique
C
Splitting
int. oblique

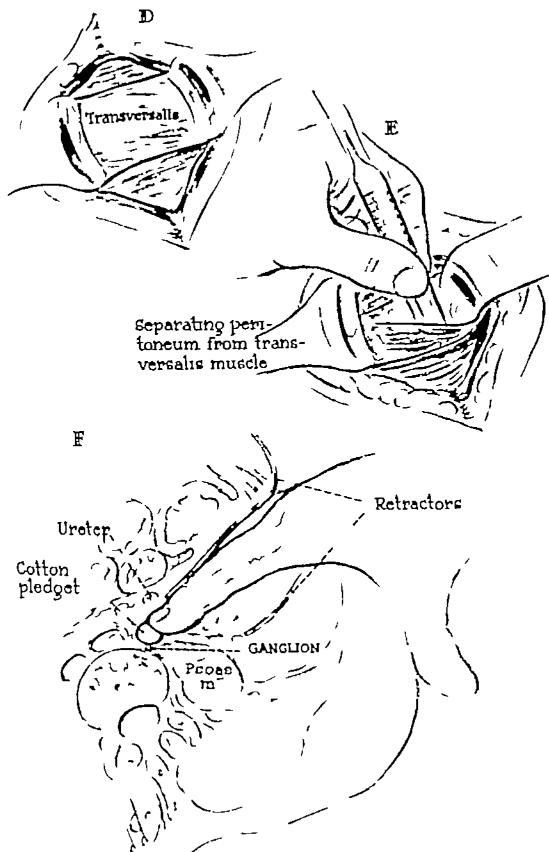
**D**
**E** Transversalis fibers separated with the blunt portion of the scalpel as far laterally as possible to prevent entering the peritoneum.

As soon as the extraperitoneal fat is visualized laterally the index and middle fingers are inserted through the muscle splitting incision By exerting pressure with the palmar surfaces of those fingers against the parietal surface of the transversalis muscle laterally the line of cleavage can be readily followed. Fingers are slid gently over the inner surface of the quadratus lumborum to the lateral margin of the psoas muscles and then elevated following the contour of the psoas muscle group

**F** Palmar surfaces of the two fingers lie directly over the psoas muscle group with the peritoneum and its contents displaced medially and upward Considerable manipulation may be eliminated by inserting a portion of a dental roll attached to a black silk string with long forceps to the site where the palmar surfaces of the index and middle fingers are kept firmly in contact with the muscle group

Fingers are removed from the site and the cotton roll is kept in contact with the muscle or the forceps

*(Continued on Plates 178 to 180)*


D
Transversalis
E
Separating peritoneum from transversalis muscle
F
Retractors
Ureter
Cotton pledget
GANGLION
Psoas m

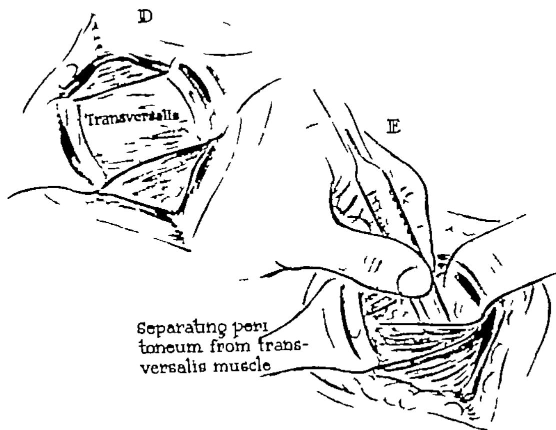
D E Transversalis fibers separated with the blunt portion of the scalpel as far laterally as possible to prevent entering the peritoneum

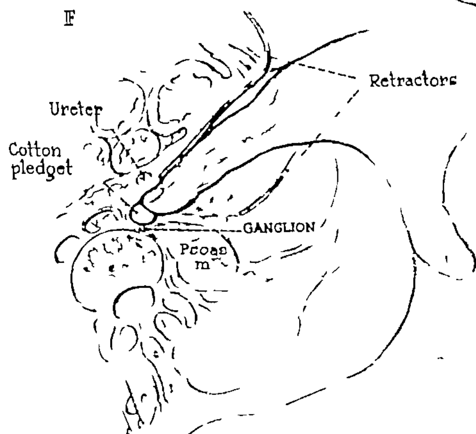
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F Palmar surfaces of the two fingers lie directly over the psoas muscle group, with the peritoneum and its contents displaced medially and upward. Considerable manipulation may be eliminated by inserting a portion of a dental roll attached to a black silk string with long forceps to the site where the palmar surfaces of the index and middle fingers are kept firmly in contact with the muscle group

*Fingers are removed from the site and the cotton roll is kept in contact with the muscle or the forceps*

*(Continued on Plates 178 to 180)*


D
Transversalis
E
Separating peri
toneum from trans-
versalis muscle


F
Retractors
Ureter
Cotton
pledget
GANGLION
Psoas
m

D
E

Transversalis fibers separated with the blunt portion of the scalpel as far laterally as possible to prevent entering the peritoneum.

As soon as the extraperitoneal fat is visualized laterally the index and middle fingers are inserted through the muscle splitting incision. By exerting pressure with the palmar surfaces of those fingers against the parietal surface of the transversalis muscle laterally the line of cleavage can be readily followed Fingers are slid gently over the inner surface of the quadratus lumborum to the lateral margin of the psoas muscles and then elevated following the contour of the psoas muscle group

F

Palmar surfaces of the two fingers lie directly over the psoas muscle group, with the peritoneum and its contents displaced medially and upward Considerable manipulation may be eliminated by inserting a portion of a dental roll attached to a black silk string with long forceps to the site where the palmar surfaces of the index and middle fingers are kept firmly in contact with the muscle group.

Fingers are removed from the site and the cotton roll is kept in contact with the muscle or the forceps.

*(Continued on Plates 178 to 180)*

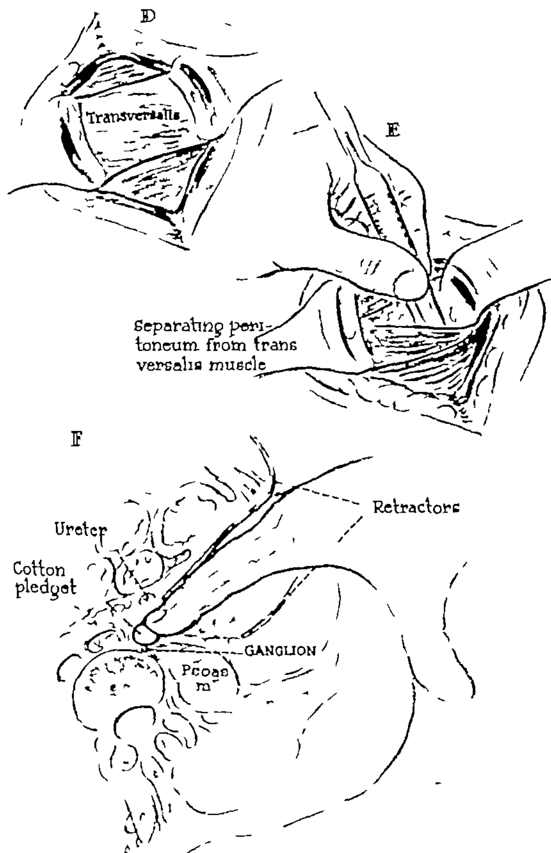

D
Transversalis
E
Separating peritoneum from transversalis muscle
F
Retractors
Ureter
Cotton pledget
GANGLION
Psoas m

Plate 177

# LUMBAR SYMPATHECTOMY

G A Grant bladder retractor is inserted by sliding it gently along the forceps to the point where the cotton roll is held on the psoas muscles. This maneuver allows retraction of the peritoneum medially so that the psoas muscles are evident, and also causes the line of reflection of the peritoneum to fold on itself forming a small white line. This line is incised, permitting entry in the proper line of cleavage. Soft tissues are retracted medially to the lateral portion of the bodies of the lumbar vertebrae

Another Grant bladder retractor is then inserted cephalad well above the attachment of the crus of the diaphragm The lumbar sympathetic chain and ganglia are evident lying in the gutter formed by the rounded portion of the bodies of the vertebrae and psoas muscles.

*(Continued on Plates 179 and 180)*

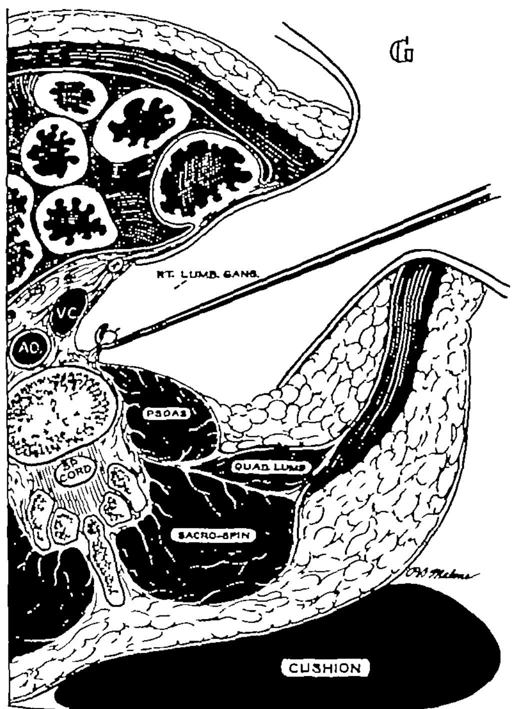

G
RT. LUMB. GANG.
VC
AO.
PSOAS
SP CORD
QUAD. LUMB.
SACRO-SPIN
CUSHION

Plate 178

H The sympathetic chain is elevated with a nerve hook and freed from its immediate tissues. The crus of the diaphragm is incised

Removal of the sympathetic trunk in this section is greatly facilitated by division of the rami before either end of the lumbar chain is divided. The sympathetic chain rarely lies *beneath the lumbar vessels on the left side this occurs quite frequently on the right side.* At times the vena cava may lie over the sympathetic chain on the right side, but it can be gently retracted. Only if a previous operation has been performed in that area might this be a handicap In such instances the vena cava may be firmly plastered down by adhesions over the sympathetic trunk.

*(Continued on Plate 180)*

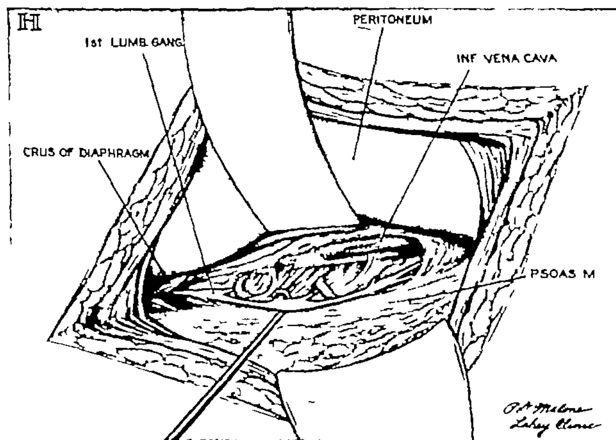
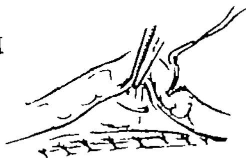

H
1st LUMB. GANG.
PERITONEUM
INF. VENA CAVA
CRUS OF DIAPHRAGM
PSOAS M.

Plate 179

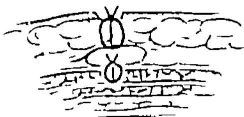
I
J
Incorrect method of closure

K
L
Correct method of closure obliterating all dead space.

I

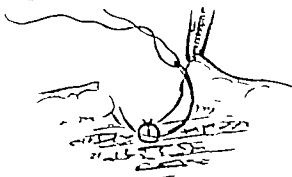


J

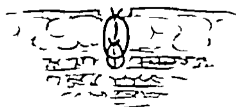


INCORRECT

K



L

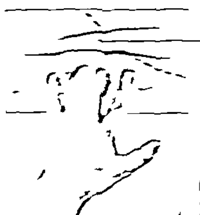


CORRECT

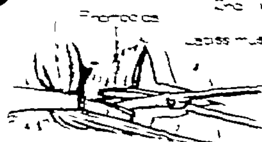
I
J
Incorrect method of closure.

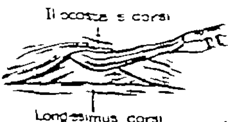
K
L
Correct method of closure obliterating all dead space.

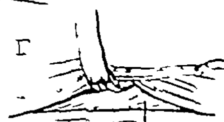




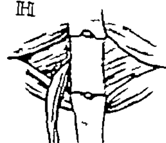





Longissimus dorsi


Intercostal muscle and periosteum


G
4th rib
Spinalis
6th rib
Longissimus
Iliocostalis


H

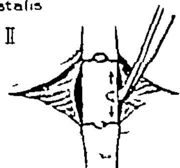

I

Plate 181

# UPPER THORACIC SYMPATHECTOMY

A Patient placed on side with shoulder slightly forward

B To determine the line of incision, the surgeon places his fingers as indicated along the spinous processes, causing the iliocostalis dorsi and longissimus dorsi muscles to bulge. The edge of the trapezius as it crosses these muscles obliquely is outlined in this manner since the bulge of the iliocostalis dorsi and longissimus dorsi is constricted when pressure is exerted in that area. The broken line indicates the lower edge of the trapezius.

The lower end of the incision should extend just beneath the edge of the trapezius, the upper edge to the level of the second rib The incision is made on the lateral third of the bulge produced by digital compression along the spinous processes, and thus varies in distance from the spinous processes according to thickness of muscle.

C Fascia over the latissimus dorsi opened immediately beneath edge of trapezius.

This allows insertion of the index finger over the iliocostalis and longissimus muscles cephalad to the first rib By this maneuver the proper ribs from which a segment is to be removed may be marked. In a round-backed or stoop-shouldered individual, the fourth and sixth ribs may be used to advantage. If the patient has a straight dorsal spine, exposure of the stellate ganglion through the third rib is preferable.

D Trapezius muscle retracted cephalad.

Usually the trapezius can be retracted sufficiently for adequate exposure of the fourth rib Occasionally it may be necessary to separate the fibers of the trapezius in their line of cleavage over the third or fourth rib for a more direct approach. Rhomboids are well developed at times and then must be incised

E Fascia between iliocostalis dorsi and longissimus dorsi incised immediately over the fourth rib A periosteal elevator is used to separate the iliocostalis laterally from the rib.

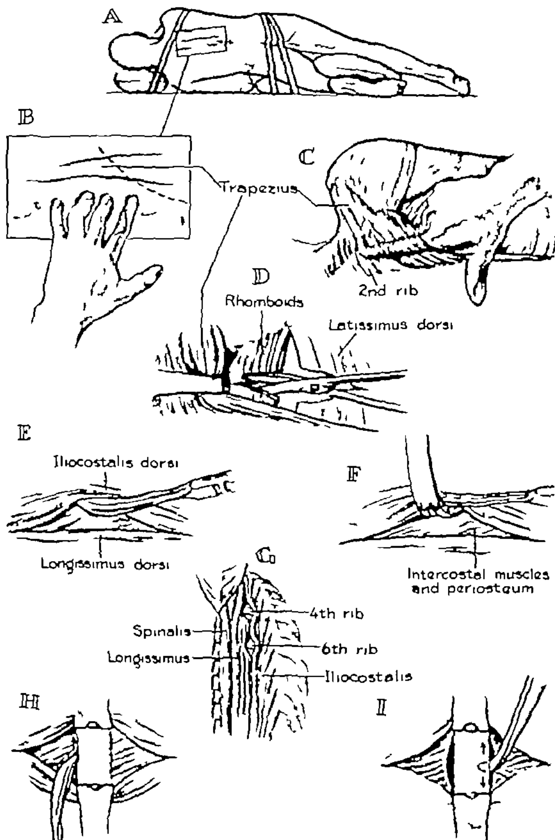
F Saddle retractor placed underneath the periosteal elevator Lateral traction is applied and the periosteal elevator removed.

G Iliocostalis and longissimus dorsi separated over the fourth and sixth ribs

H Broad-bladed rounded sharp periosteal elevator (Hedblom) used to separate intercostal muscles from edges of rib

I Periosteum separated from rib with a right angle periosteal elevator

*(Continued on Plate 182)*


A
B
C
D
E
F
G
H
I
Trapezius
2nd rib
Rhomboids
Latissimus dorsi
Iliocostalis dorsi
Longissimus dorsi
Intercostal muscles and periosteum
4th rib
Spinalis
6th rib
Longissimus
Iliocostalis

# UPPER THORACIC SYMPATHECTOMY

J Rounded periosteal elevator inserted under the rib and elevated to allow the lateral margin of the rib to be cut with rib shears. The medial end of the rib is held with a large hemostat the rib is also cut flush with the transverse process medially

K Cotton pledget inserted under the medial edge of the rib that has not been excised by rib shears This portion is removed with rongeurs.

L *Parietal pleura separated from attachments. Care must be taken to avoid opening the parietal* pleura.

The lung is depressed with a spatula to allow excision of the stump of the rib

M Finger inserted into lateral gutter parietal pleura gently separated from tissues with a sweeping motion

N Relationship of windows made by partial removal of the fourth and sixth ribs.

*Parietal pleura cannot be separated for the entire length with the index finger but this* facilitates the introduction of a spatula The remainder of the dissection can be carried out by following the sympathetic trunk to the stellate ganglion. The sympathetic trunk is elevated with a nerve hook as soon as it presents *beneath the window made in the fourth rib. Rami* communicantes are divided flush with the intercostal nerves however the trunk is not divided throughout the dissection and division of the rami communicantes. The ganglion of the second intercostal nerve is not freed *thus rami are left intact.* This allows the maneuver as demonstrated in O

O *Sympathetic trunk rotated around nerve hook In this manner the first thoracic ganglion* can be separated from the inferior cervical ganglion without difficulty

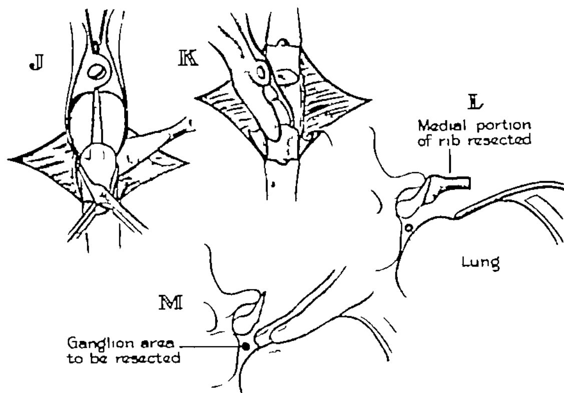
Care must be taken not to place too much traction on the inferior cervical trunk if a more complete denervation is necessary in order to prevent a Horner s syndrome. The entire stellate ganglion may be removed if necessary

Rami communicantes are divided *at the second rib the trunk can be brought down out of* the window in the fourth rib A similar procedure is carried out through the window in the sixth rib leaving rami attached to the fifth and eighth intercostal nerves. This again facilitates division *of the rami communicantes at the intervening intercostal nerve. Rami are divided* from the uppermost and the lowermost intercostal nerves. The trunk is divided beneath the eighth or ninth rib and is separated from the greater splanchnic nerve.

P Closure of deep fascia with interrupted layers of fine stainless steel wire.

Q Closure of skin with end-on mattress black silk sutures. A catheter is left in the cavity through the fourth rib until closure is completed

Air collected in the extrapleural space is allowed to escape as the anesthetist increases pulmonary pressure the tube is then pulled out through the closed incision


J
K
L
Medial portion
of rib resected
Lung
M
Ganglion area
to be resected
N
O
4
6
P
Q
Ellen Cole

J Rounded periosteal elevator inserted under the rib and elevated to allow the lateral margin of the rib to be cut with rib shears The medial end of the rib is held with a large hemostat the rib is also cut flush with the transverse process medially

K Cotton pledget inserted under the medial edge of the rib that has not been excised by rib shears. This portion is removed with rongeurs.

L Parietal pleura separated from attachments. Care must be taken to avoid opening the parietal pleura.

The lung is depressed with a spatula to allow excision of the stump of the rib.

M Finger inserted into lateral gutter parietal pleura gently separated from tissues with a sweeping motion.

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O Sympathetic trunk rotated around nerve hook. In this manner the first thoracic ganglion can be separated from the inferior cervical ganglion without difficulty

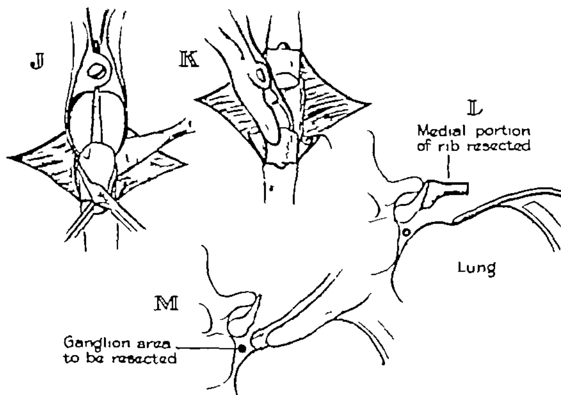
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P Closure of deep fascia with interrupted layers of fine stainless steel wire.

Q Closure of skin with end-on mattress black silk sutures. A catheter is left in the cavity through the fourth rib until closure is completed

Air collected in the extrapleural space is allowed to escape as the anesthetist increases pulmonary pressure the tube is then pulled out through the closed incision




N

O

4

6

P

Q

Ellen Cole

# THORACOLUMBAR SYMPATHECTOMY

**B** Visualization of the entire splanchnic distribution from the inside and its relationship to the apertures through which the removal is accomplished.

*Inset* Separation of ganglion from intercostal vessels before division of the rami communicantes.

The position of the patient during operation is of utmost importance in facilitating the procedure a lateral semiprone position is used. The longissimus dorsi and iliocostalis dorsi are separated over the medial portion of the eleventh rib as well as over the seventh. The technique used for removing the medial 4 cm. of rib is again the same as that outlined in Upper Thoracic Sympathectomy (Plates 181 and 182).

To prevent deformity the rib should not be removed farther laterally than the width of the iliocostalis dorsi and longissimus dorsi. Removal of as much as possible of the rib vertebrally allows more adequate exposure. Considerable care should be taken to enter the proper line of cleavage between the parietal pleura and the endothoracic fascia. When the line of cleavage has been established, it can be followed medially with a semisharp Hedblom periosteal elevator to the anterolateral border of the vertebral bodies where the greater splanchnic lies.

The index finger is inserted into the space and the line of cleavage followed cephalad and caudad through the openings of the seventh and eleventh ribs. While following the line of cleavage, caution should be exercised to keep the palmar surface of the index finger firmly against the endothoracic fascia rather than against the parietal pleura this will prevent rupture of the pleura. Even though considerable care has been taken, the pleura may be unintentionally opened the mere opening of the pleura is not disastrous, and does not cause more than minor difficulties at the time of operation.

After the pleura has been separated paravertebrally cephalad to the level of the fourth thoracic ganglion and caudad to the attachment of the diaphragm, the greater splanchnic nerve is mobilized along its entire course. The greater splanchnic nerve is mobilized first because it lies in a relatively avascular bed.

With the patient in a semiprone position, if slight oozing should occur at the time the ganglia are mobilized and their respective rami divided, blood gravitates toward the mediastinum. If the greater splanchnic were severed after the ganglia had been mobilized, it might be obscured by blood-stained tissue. Great care is taken in mobilizing the nerve fibers making up the greater splanchnic from the individual ganglia. There is considerable difference in the size of the ganglia, and a few may not have individual fibers leading to the greater splanchnic nerve.

After the fourth thoracic ganglion has been mobilized, the trunk is divided above it. The entire mobilized upper sympathetic trunk and its branches are then pulled down through the aperture made by the removal of the eleventh rib. Care is taken to keep the entire system in continuity so that there can be no possibility of leaving ganglia or fibers that lead to the thoracic aorta. To avoid unnecessary bleeding, the thoracic ganglia are carefully separated from the intercostal nerve and artery before dividing the rami. All bleeding, even from a larger intercostal artery can be controlled by the electrosurgical unit.

Dissection of the entire system is less difficult if the thoracic trunk is not divided until the desired number of ganglia to be removed have been mobilized. After the thoracic sympathetic trunk and splanchnic nerve have been completely mobilized in continuity to the diaphragm, the iliocostalis dorsi and longissimus dorsi (which merge into the sacrospinalis at the level of the twelfth rib) are retracted medially toward the spine. This permits incision of the lumbodorsal and transversalis fascia. Care is taken not to injure the iliohypogastric nerve during the dissection. The retroperitoneal space is entered and soft tissues are retracted anteriorly

The greater splanchnic nerve can be readily identified as it emerges through the diaphragm, usually through a hiatus of its own (as shown in this plate). In some instances it may emerge through the aortic hiatus. The greater and lesser splanchnic nerves usually emerge through the same aperture, but in some patients they emerge through separate apertures in the diaphragm. The greater and lesser splanchnic nerves are then detached from the celiac ganglion. The lesser splanchnic usually has fibers entering the celiac and aorticorenal ganglia. The first, second, and at times the third lumbar ganglia are mobilized, and the sympathetic trunk is divided beneath the third ganglion. The crus of the diaphragm usually covers part of the first lumbar ganglion. With the distal end of the lumbar trunk kept under slight tension, the crus is incised the first lumbar ganglion is readily exposed and its rami divided.

The incision through the crus of the diaphragm is increased for a distance of several millimeters so that the aperture in the diaphragm is of sufficient size to permit the ganglia to be pulled through it from above. The mobilized cephalad end of the thoracic trunk and the sympathetic nerves are then grasped with forceps. By gentle traction, the subdiaphragmatic portion of the greater and lesser splanchnic, as well as the lumbar sympathetic trunk, can be readily brought through the diaphragmatic aperture. In this manner the entire system is kept in continuity and there can be no question as to the completeness of the procedure.

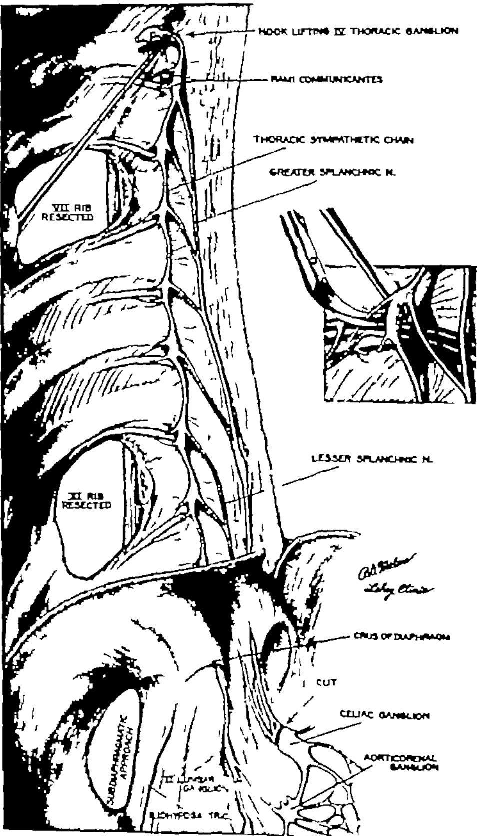

HOOK LIFTING IV THORACIC GANGLION
RAMI COMMUNICANTES
THORACIC SYMPATHETIC CHAIN
GREATER SPLANCHNIC N.
VII RIB RESECTED
LESSER SPLANCHNIC N.
XI RIB RESECTED
CRUS OF DIAPHRAGM
CUT
CELIAC GANGLION
AORTICORENAL GANGLION
SUBDIAPHRAGMATIC APPROACH
B

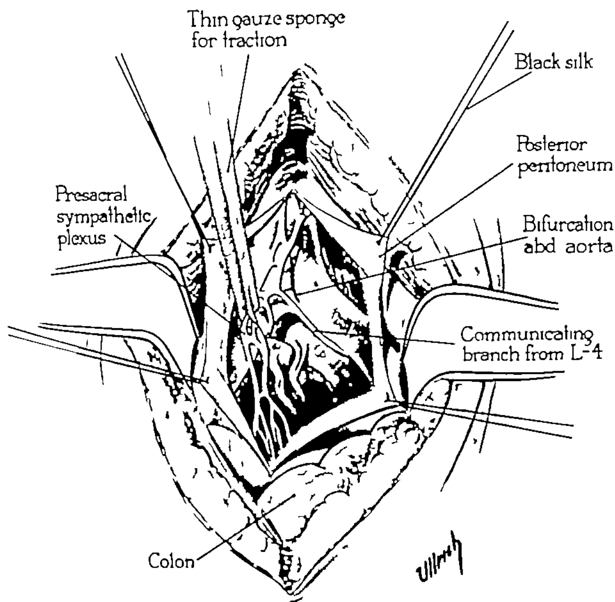
Plate 184

# PRESACRAL NEURECTOMY

With the patient under spinal or adequate general anesthesia and in a Trendelenburg position, a midline abdominal incision is made extending 5 to 7 cm. above the umbilicus and carried down two-thirds of the way to the pubis

The posterior peritoneum is opened exposing the bifurcation of the abdominal aorta. The edges of the posterior peritoneum are separated with black silk sutures as indicated, to allow adequate exposure of the common iliac vessels. The superior hypogastric plexus is exposed by gently brushing the loose connective and lymphatic tissues aside with a cotton pledget. The sympathetic plexus can be seen best as it extends over the bifurcation of the aorta two large strands with interlacing fibers are usually present.

The best procedure is to elevate the entire plexus *en masse* and divide the connecting smaller strands while dissecting upward over the abdominal aorta for 5 to 7 cm and then downward along the sacrum. The dissection is simplified by keeping the mass intact at both ends until all intervening communicating fibers have been divided. The main trunks are then severed above and below All bleeding points are carefully controlled. If lymph channels have been opened, this can be immediately detected by the escape of lymph. These channels are occluded with a ligature of fine black silk or a silver clip The posterior peritoneum is closed and the usual closure of the abdominal wall is made.


Thin gauze sponge for traction
Black silk
Posterior peritoneum
Presacral sympathetic plexus
Bifurcation abd aorta
Communicating branch from L-4
Colon
Ullrich

# Part IV EXTREMITIES

## *Section 1* PERIPHERAL NERVES



## *Section 2* LUMBAR PLEXUS

## SCIATIC NERVE AT THE SCIATIC NOTCH

**A** Line of incision

**B** Gluteus maximus muscle divided laterally and reflected medially exposing the sciatic nerve trunk at the sciatic notch and the neuroma.

Excision of the neuroma is made as in the operation for Neuromas of the Brachial Plexus and Lumbar Plexus (Plates 171 and 203).

SCIATIC NERVE AT THE SCIATIC NOTCH

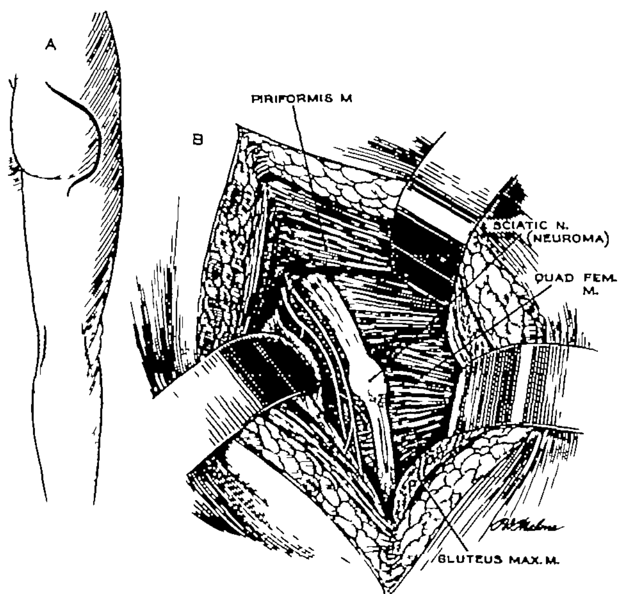



Plate 186

*Incision and Exposure*

**A** If the sciatic nerve is injured or involved with tumor below the sciatic notch, incision is made as indicated

**B** The semitendinosus and biceps femoris muscles are separated, exposing the trunk of the sciatic nerve.

If the sciatic nerve has been lacerated, it is necessary to excise the involved tissue until healthy nerve has been reached. Nerve ends are then brought together as in the operation for Sciatic Nerve at the Sciatic Notch (Plate 186) At times it is necessary to undermine the muscle tissue and free the nerve trunks cephalad and caudad to allow primary suture Flexion at the knee usually permits excision of a considerable area of the sciatic nerve.

*Excision and Suture*

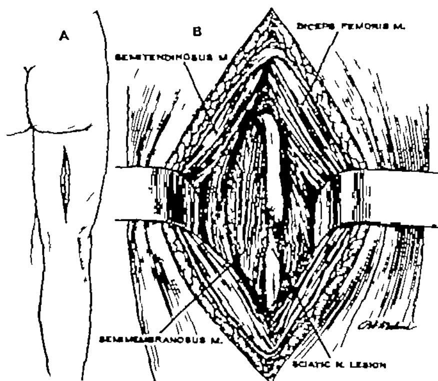
**C** Laceration of the sciatic nerve trunk with amputation neuromas.

**D** Proximal and distal portions of the sciatic nerve dissected and then excised until healthy nerve fibers are visible.

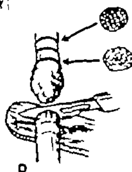
**E** Needle inserted through the central portion of the cephalad and caudad sections of the nerve.

**F** Sutures inserted through the nerve sheath.

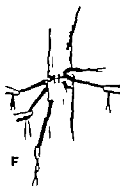
**G** The needle which has kept the nerves approximated (in *E* and *F*) has been removed and the sutures accurately placed.


A
B
BICEPS FEMORIS M.
SEMITENDINOSUS M.
SEMIMEMBRANOSUS M.
SCIATIC N. LESION


C


D


E


F


G

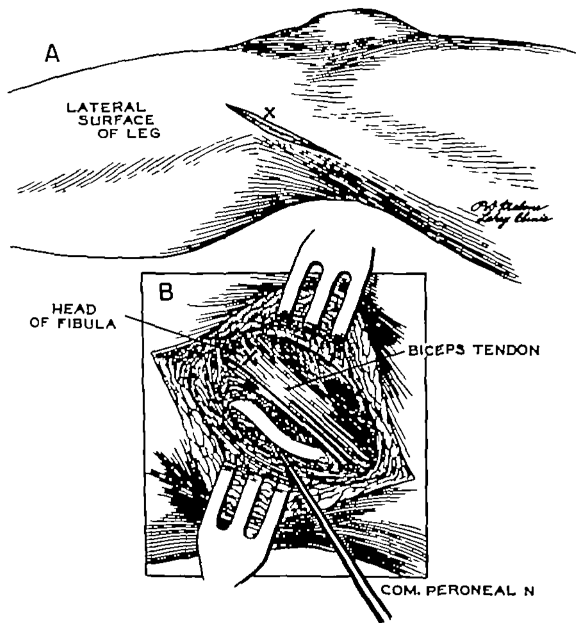
Plate 187

SURGERY OF THE PERIPHERAL NERVES EXPOSURE OF THE COMMON PERONEAL NERVE

**A** Line of incision.

**B** Exposure of the common peroneal nerve just before bifurcation into the deep and superficial branches

Plate 188


A
LATERAL
SURFACE
OF LEG
X
B
HEAD
OF FIBULA
BICEPS TENDON
COM. PERONEAL N

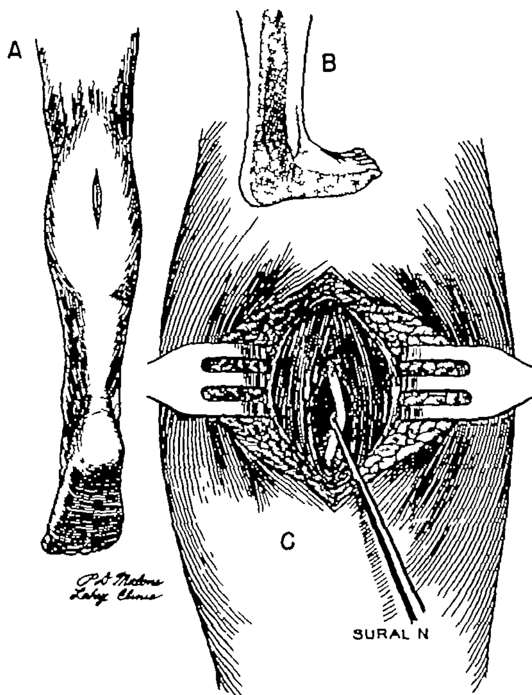
# SURGERY OF THE PERIPHERAL NERVES EXPOSURE OF THE SURAL NERVE

**A** Line of incision.

**B** Dotted area approximate area of anesthesia that will develop from section of the sural nerve at the level indicated in A.

**C** Sural nerve readily identified, lying in the groove of the gastrocnemius just lateral to the saphena parva vein.

## SURGERY OF THE PERIPHERAL NERVES EXPOSURE OF THE SURAL NERVE



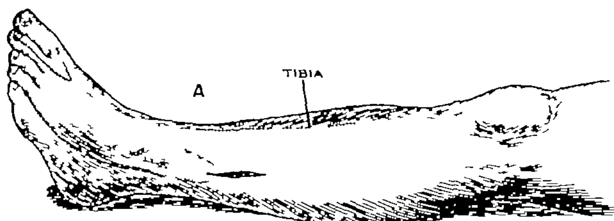
# SURGERY OF THE PERIPHERAL NERVES APPROACH TO THE SUPERFICIAL AND DEEP PERONEAL CUTANEOUS BRANCHES

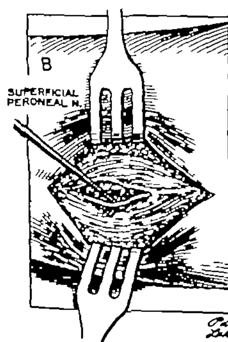
**A** A linear incision made approximately 15 cm. above the external malleolus, centering over the line of cleavage between the tibialis anterior and the extensor hallucis longus muscles. Dotted area indicates the area of sensory anesthesia that develops after section of the superficial peroneal nerve at that level

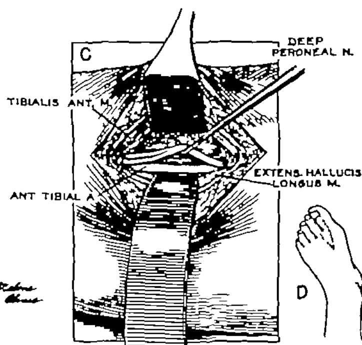
**B** Fascia uniting the extensor digitorum longus and extensor hallucis longus is evident and is incised. The superficial peroneal nerve lies on the surface in the line of cleavage of the extensor digitorum longus and extensor hallucis longus

**C** Skin retracted medially The line of cleavage between the extensor hallucis longus and the tibialis anterior is entered The deep peroneal nerve is easily identified and divided, care being taken not to injure the arteries.

**D** Anesthesia that results from division of the deep peroneal nerve dorsally


TIBIA
A


B
SUPERFICIAL PERONEAL N.


C
DEEP PERONEAL N.
TIBIALIS ANT. M.
EXTENS. HALLUCIS LONGUS M.
ANT TIBIAL A


D

# SURGERY OF THE PERIPHERAL NERVES EXPOSURE OF SAPHENOUS AND POSTERIOR TIBIAL NERVES

**A** Location of incision, about 12.5 cm. above the internal malleolus. Dotted area region in which sensory change takes place following division of the saphenous nerve at this level.

**B** The saphenous nerve lies next to the saphenous vein and is evident lying either over the fascia or in a small septum of the fascia overlying the flexor digitorum longus and soleus muscles.

A small segment of the nerve is usually excised or may be simply divided with a sharp knife.

**C** Dotted area region of anesthesia

**D** Fascia overlying the flexor digitorum longus and soleus muscles is divided and the line of cleavage between the two muscles is followed to the tibialis nerve. See cross section, F

In patients with marked ischemia of the foot, it is wise to save the artery that lies in the center of the nerve trunk.

**E**
**F** Nerve fibers separated from the artery and divided, leaving the small artery intact.

# SURGERY OF THE PERIPHERAL NERVES EXPOSURE OF SAPHENOUS AND POSTERIOR TIBIAL NERVES

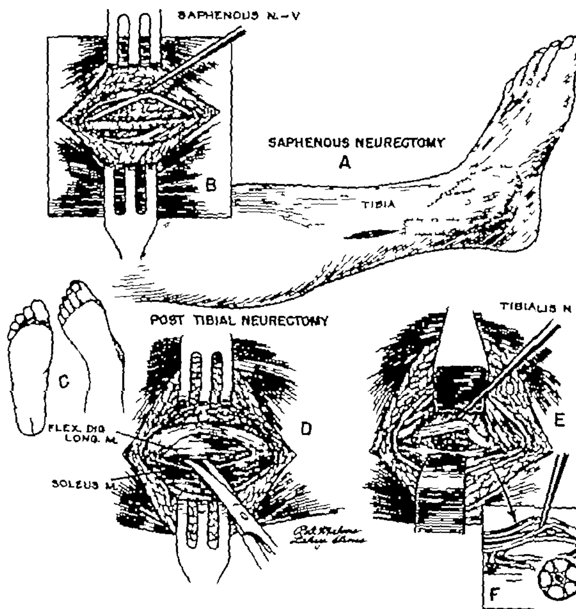



Plate 191

# SURGERY OF THE PERIPHERAL NERVES CROSS SECTION OF LOWER THIRD OF LEG AT LEVEL OF NERVE SECTION

This cross section demonstrates the relationship of structures and the line of cleavage that must be followed to reach the individual nerves.

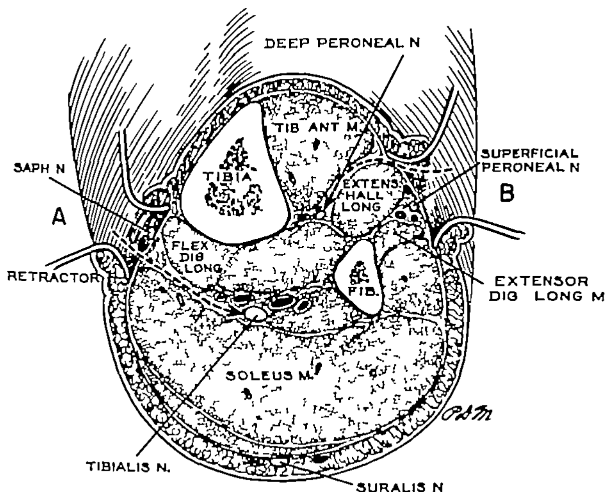
**A** Site of incision for exposure of the saphenous nerve and the line of cleavage that must be followed to reach the tibial nerve.

**B** Incision for exposure of the superficial peroneal nerve which lies in the fascial groove between the extensor hallucis and extensor digitorum longus muscles.

To expose the deep peroneal nerve, the line of cleavage (dotted line) between the extensor hallucis longus and tibialis anticus muscles can be entered by elevating the subcutaneous tissues.

Plate 192

SURGERY OF THE PERIPHERAL NERVES CROSS SECTION OF LOWER THIRD OF LEG AT LEVEL OF NERVE SECTION



## MEDIAN NERVE AT ELBOW

**A** Type of incision.

**B** Dotted line incision over the fascia and the lacertus fibrosus

**C** Exposure of the median nerve and its relationship to the contiguous structures. The dotted line over the fibers of the median nerve indicates the line of incision through the pronator teres when further exposure is necessary

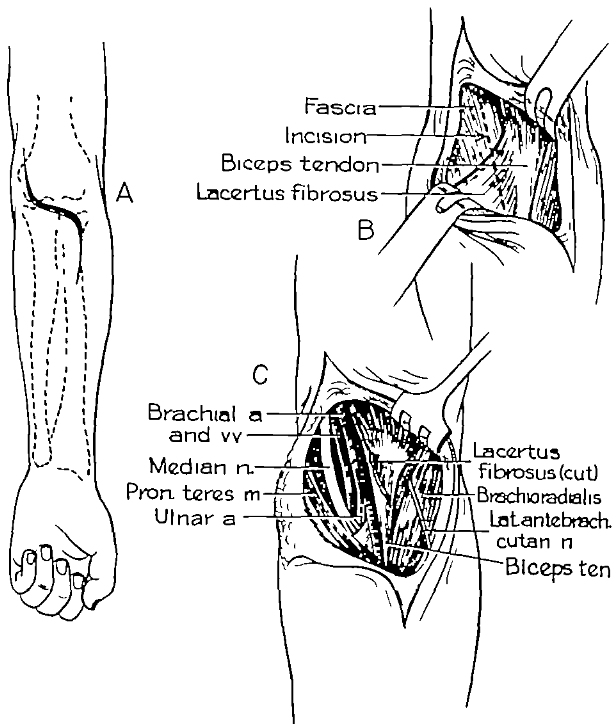

A
Fascia
Incision
Biceps tendon
Lacertus fibrosus
B
C
Brachial a
and vv
Median n.
Pron. teres m
Ulnar a
Lacertus
fibrosus (cut)
Brachioradialis
Lat. antebrach.
cutan n
Biceps ten

Plate 193

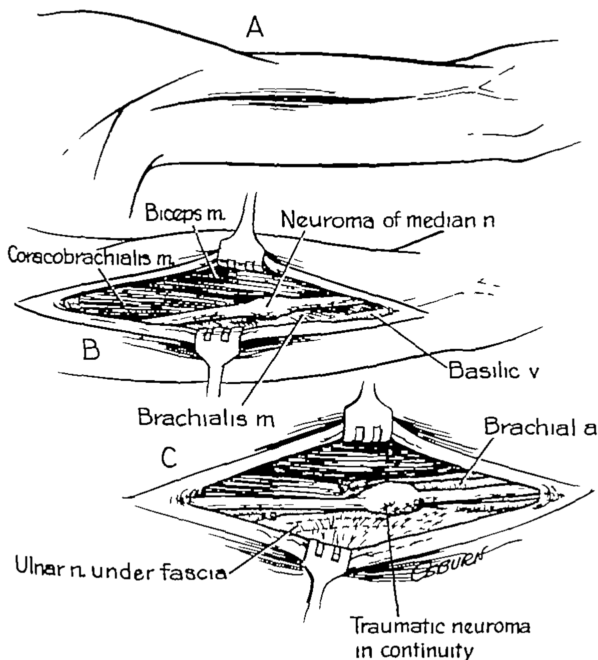
# SURGERY OF THE PERIPHERAL NERVES
## MEDIAN NERVE IN ARM

**A** Incision along the medial border of the biceps is made similar to the incision for exposure of the ulnar nerve. The median and ulnar nerves can usually be easily palpated through the skin, and the incision is made accordingly

**B** Brachial fascia has been opened and the nerve exposed.

**C** Relationship of median nerve to ulnar nerve and traumatic neuroma in continuity

If functioning nerve fibers are still present, treatment is the same as that for neuroma in continuity in the ulnar nerve at the elbow If no functioning fibers are present, the neuroma is excised as in the operative procedure for laceration of the Sciatic Nerve (Plate 187)


A
Biceps m.
Neuroma of median n
Coracobrachialis m.
B
Basilic v
Brachialis m
Brachial a
C
Ulnar n. under fascia
COBURN
Traumatic neuroma
in continuity

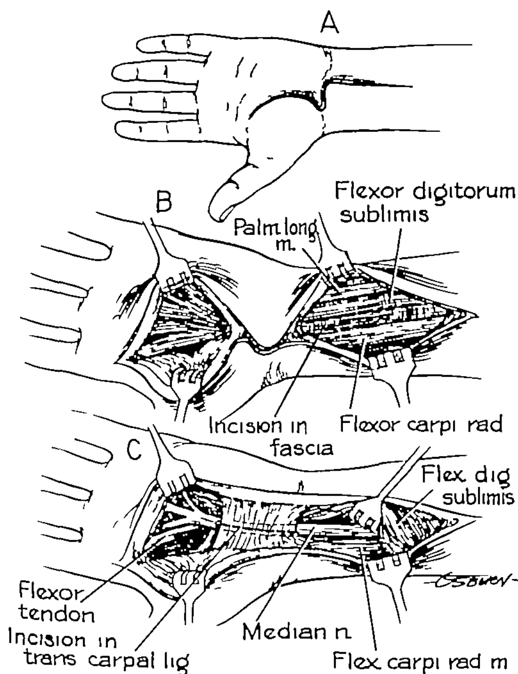
## MEDIAN NERVE AT WRIST

**A** Type of incision.

**B** Relationship of tissues superficial to the nerve. Dotted line indicates the fascia to be excised over the nerve trunk.

**C** Dotted line incision to be made through the transverse carpal ligament if necessary for adequate exposure.

Plate 195


A
B
Flexor digitorum
sublimis
Palm long
m.
Incision in
fascia
Flexor carpi rad
C
Flex dig
sublimis
Flexor
tendon
Incision in
trans carpal lig
Median n.
Flex carpi rad m

# SURGERY OF THE PERIPHERAL NERVES MEDIAN NERVE COMPRESSION AT WRIST (CARPAL TUNNEL SYNDROME)

A Line of incision

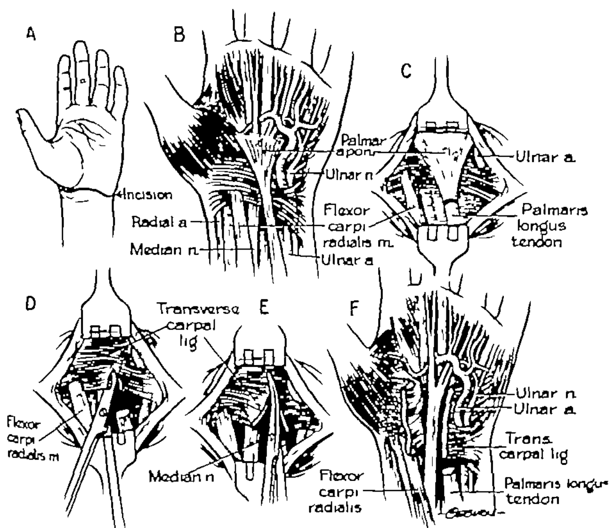
B Normal relationship of structures.

C Palmaris longus tendon divided on ulnar side of median nerve. Dotted line line of incision of fascia over median nerve.

D Freeing of median nerve from transverse carpal ligament.

E Incision of transverse carpal ligament.

F Transverse carpal ligament completely divided.


A
B
C
Incision
Radial a
Median n.
Palmar apon.
Ulnar n
Flexor carpi radialis m.
Ulnar a
Ulnar a.
Palmaris longus tendon
D
E
F
Transverse carpal lig
Flexor carpi radialis m
Median n
Flexor carpi radialis
Ulnar n.
Ulnar a.
Trans. carpal lig
Palmaris longus tendon

# SURGERY OF THE PERIPHERAL NERVES TRANSPLANTATION OF ULNAR NERVE AT ELBOW

A Line of incision.

B The ulnar nerve is initially exposed above the elbow so that it can be readily followed through the ulnar groove.

It is important to dissect the normal portion of the nerve initially since the fascia overlying the nerve at the elbow proper is usually scarred and firmly adherent to the overlying fascia.

C The nerve, including the traumatic neuroma, has been dissected free.

The skin and subcutaneous tissues are separated from the fascia medially If normal functioning nerve fibers are present in continuity in the neuroma, the neuroma is excised and the nerve ends reunited

D A new bed has been made for the nerve for transplantation.

*(Continued on Plate 198)*

SURGERY OF THE PERIPHERAL NERVES TRANSPLANTATION OF ULNAR NERVE AT ELBOW

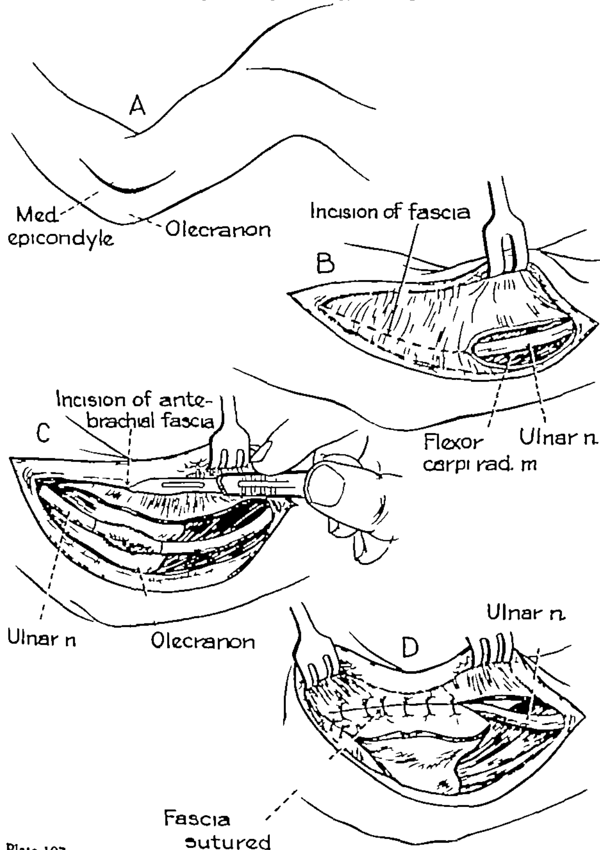


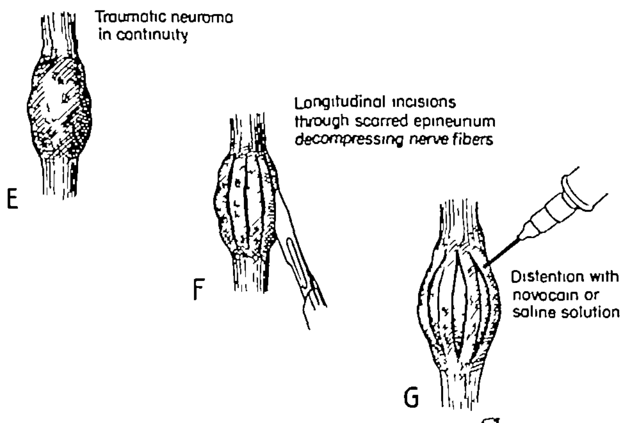

Plate 197

If functioning nerve fibers are still present in the neuroma in continuity the nerve fibers are decompressed.

**E** Neuroma in continuity

**F** Multiple incisions for decompressing nerve fibers.

**G** Injection of procaine (Novocain) or saline.


Traumatic neuroma
in continuity
E
Longitudinal incisions
through scarred epineurium
decompressing nerve fibers
F
Distention with
novocain or
saline solution
G

## SURGERY OF THE PERIPHERAL NERVES EXPOSURE OF ULNAR NERVE IN ARM

**A** Line of incision on medial aspect of arm.

**B** Brachial fascia overlying the nerve divided.

**C** Nerve exposed

**D** Cross section relationship of structures

SURGERY OF THE PERIPHERAL NERVES EXPOSURE OF ULNAR NERVE IN ARM

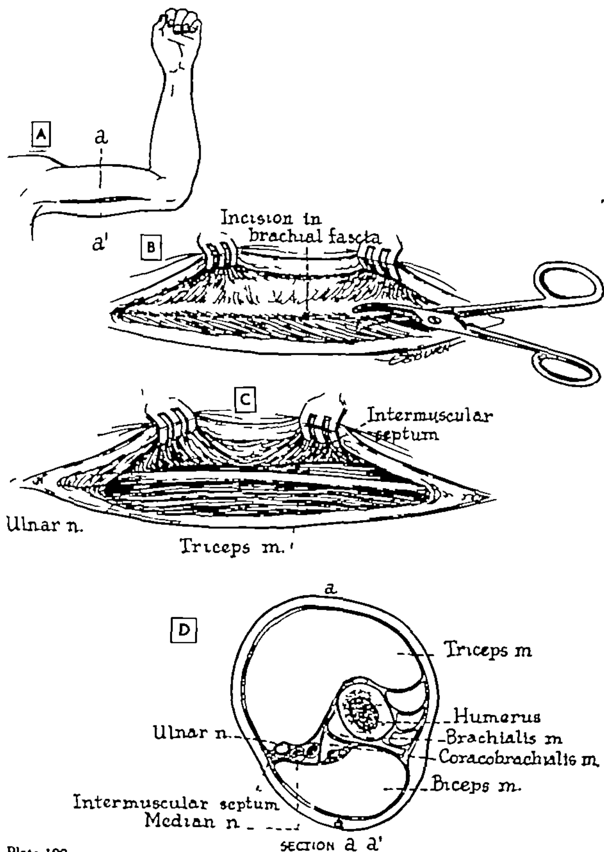



Plate 199

## SURGERY OF THE PERIPHERAL NERVES EXPOSURE OF ULNAR NERVE IN ARM

**A** Line of incision on medial aspect of arm.

**B** Brachial fascia overlying the nerve divided.

**C** Nerve exposed.

**D** Cross section relationship of structures.

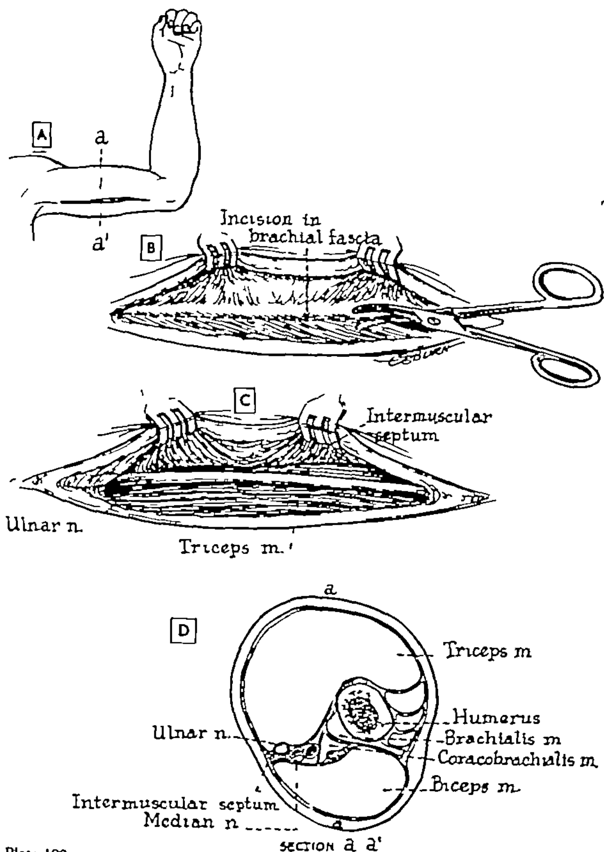

A
a
a'
Incision in brachial fascia
B
C
Intermuscular septum
Ulnar n.
Triceps m.
D
a
Triceps m
Humerus
Brachialis m
Coracobrachialis m
Ulnar n.
Biceps m
Intermuscular septum
Median n
a
SECTION a a'

Plate 199

# SURGERY OF THE PERIPHERAL NERVES EXPOSURE OF ULNAR NERVE AT WRIST

**A** Line of incision

**B** Dotted line incision made through the fascia medial to the flexor carpi ulnaris muscle to expose ulnar nerve.

**C** Complete traumatic separation of the ulnar nerve. Relationship of contiguous structures. Nerve ends are excised to fresh nerve tissue and resutured.

To obtain adequate length of nerve for anastomosis, it may occasionally be necessary to extend the incision in the forearm. In most instances, however adequate lengthening of the nerve may be obtained by undermining the tissues upward along the course of the nerve itself.

# SURGERY OF THE PERIPHERAL NERVES EXPOSURE OF ULNAR NERVE AT WRIST

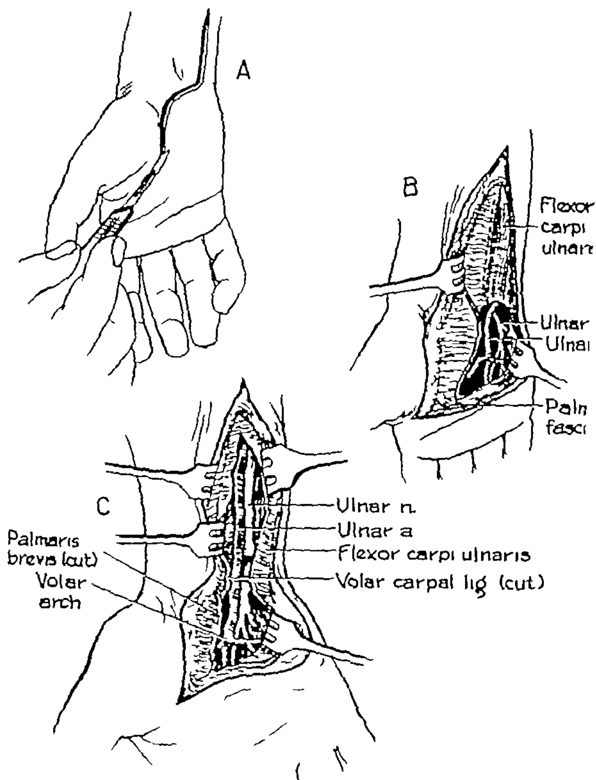



Plate 200

# RADIAL NERVE IN ARM

**A** Position of patient and line of incision.

**B** Relationship of anatomical structures in the arm

**C** Lateral head separated from the long head of the triceps muscle.

**D** Exposure of the upper portion of the radial nerve.

**E** Old fracture of the humerus.

If a portion of the radial nerve is to be resected because of laceration or neuroma and the ends of the nerve cannot be brought together a portion of the humerus is resected, as indicated by the dotted lines This allows the radial nerve to be transplanted and the ends brought together by shortening the humerus

RADIAL NERVE IN ARM

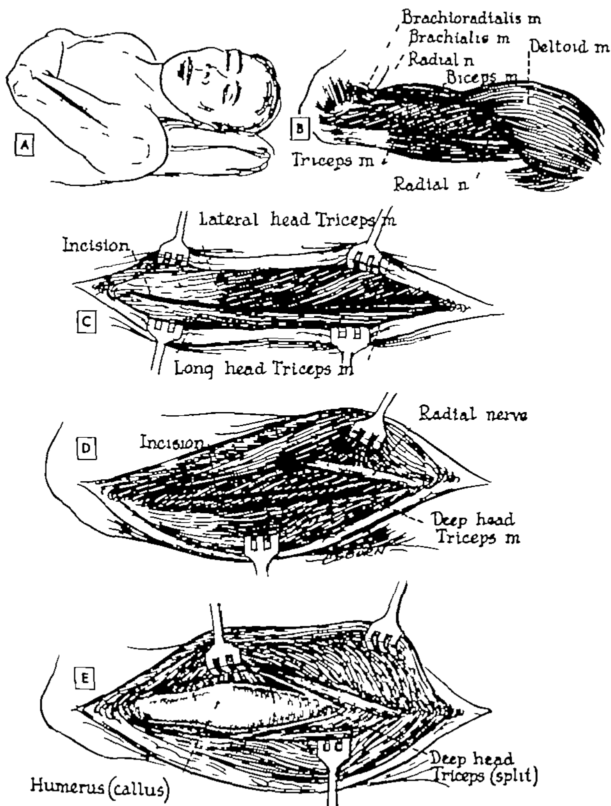



Plate 201

## NEUROMA OF THE LUMBAR PLEXUS EXPLORATION

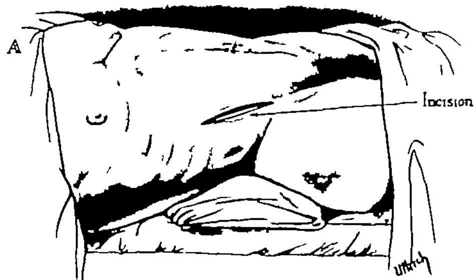
**A** The patient is placed in a slightly oblique position with the hip elevated on the side of the incision. The incision is extended from the tenth rib to the level of the anterior spine of the ilium (refer to Lumbar Sympathectomy Plates 176 to 180).

**B** Normal relationship of structures.

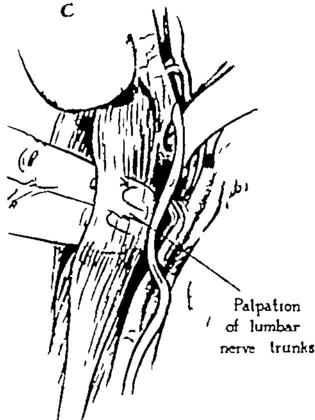
**C** Index and middle fingers inserted retroperitoneally

A sweeping motion cephalad and caudad along the iliopsoas muscle readily detects a neuroma involving the lumbar plexus even though the neuroma is of small size.

*(Continued on Plate 203)*


A
Incision


B
Normal relationship
of structures


C
Palpation
of lumbar
nerve trunks

**D** Retroperitoneal operative exposure (refer to Lumbar Sympathectomy Plates 176 to 180) The iliopsoas muscle is retracted medially and the neuroma exposed

**E** Exposure of neuroma by retracting psoas muscle.

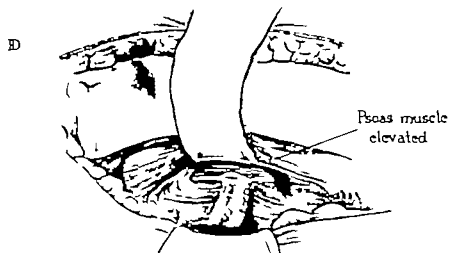
**F** Longitudinal incision made over the fusiform enlargement of the involved nerve trunk Slight pressure exerted over the edges of the incision allows the tumor to enucleate itself

**G** The entering nerve fibers to the tumor and the emerging nerve fibers are divided allowing the remaining nerve fibers to remain intact The nerve sheath is closed with interrupted fine black silk sutures

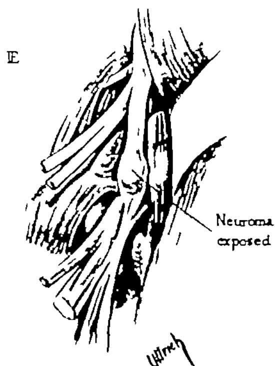
For closure of incision, refer to Lumbar Sympathectomy

This approach is used also for the extraspinal portion of dumbbell neurofibromas of the lumbar spinal canal.

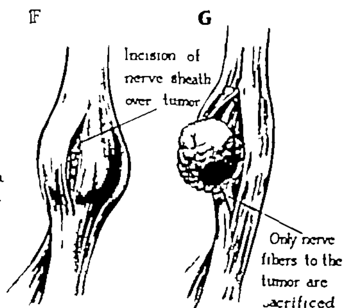
D


Psoas muscle
elevated

E


Neuroma
exposed

F G


Incision of
nerve sheath
over tumor
Only nerve
fibers to the
tumor are
sacrificed

# Part V SPINE

When the surgeon encounters an intramedullary spinal cord tumor he faces a serious decision between removing the tumor or merely performing a decompression by leaving the dura widely open and dividing the dentate ligament.

If the patient is not incapacitated by the tumor or has minor symptoms, decompression followed by x ray therapy is the procedure of choice. On the other hand if the patient is greatly incapacitated as the result of tumor if the spinal cord is considerably attenuated dorsally and—furthermore— if the patient and the family have been thoroughly informed of the possible disastrous results from removing the tumor incision of the median raphe of the spinal cord in its most attenuated portion is justified. Whether the tumor has a delineating capsule or whether it cannot be readily *separated from the cord can then be determined. If the latter is the case, conservatism is the better* part of valor If however the tumor seems to have a pseudocapsule, enucleation is possible.

*Enucleation of an Intramedullary Spinal Cord Tumor*

**A** Incision over the most attenuated portion.

**B** Separation of the inferior margin of the tumor from the spinal cord.

**C** By using gentle dissection the tumor can be carefully separated from its tumor bed.

**D** *Tumor removed, leaving a large cavity in the spinal cord*

Bleeding points should be controlled only with small stamps of Gelfoam these are allowed to remain in place until the oozing stops and are then removed.

In the complete removal of an intramedullary tumor the dura should be closed with inter rupted black silk. Closure is made with several layers of interrupted black silk or stainless steel wire I prefer stainless steel wire, especially in the upper dorsal region where considerable traction may be placed on the muscle and skin postoperatively if the patient moves the shoulders vigorously before sufficient healing has taken place.

Postoperative swelling of the spinal cord can be obviated to a considerable degree with the use of urea solutions given intravenously

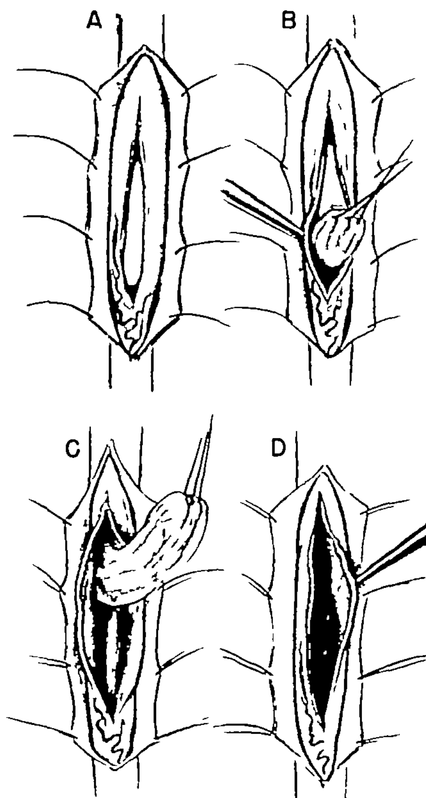



Plate 204

Since meningiomas are attached to the dura, removal of the dura with the tumor is important. Meningiomas posterior to the cord present no particular difficulties except for the vascular dura.

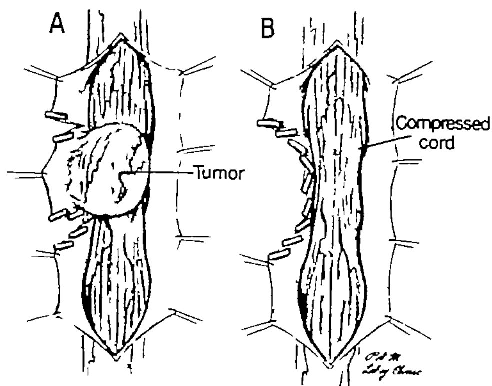
**A** Silver clips placed along the edge as the dura is incised.

This simplifies the procedure since the tumor derives all its blood supply from the dural attachment All bleeding ceases as soon as the involved dura over the tumor has been incised

**B** Tumor removed

The dural defect is closed with a dural graft or covered with a thin layer of Gelfoam If the dura is left open, the muscle must be accurately closed with several layers of interrupted black silk sutures or stainless steel wire. Drainage is not indicated

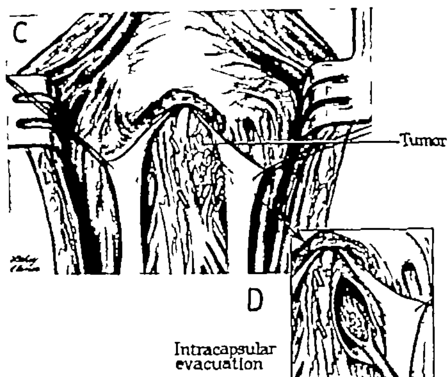
(*Continued on Plate 206*)


A
B
Tumor
Compressed
cord

**C**
**D**

Meningiomas anterior to the cord should be removed piecemeal. After the bulk of the tumor has been removed, sufficient room is usually present to excise the dura that is involved with the tumor. In this instance it is not necessary to repair the dural defect; however, the dorsal dura is closed watertight.

At all times caution should be used in the manipulation of the spinal cord in the immediate region of the tumor. All pressure should be exerted away from the cord and never toward it.


C
Tumor
D
Intracapsular
evacuation

# NEUROFIBROMA OF CORD

**A** Neurofibroma located in the posterior surface of the cord

For all extramedullary tumors a complete laminectomy should be performed covering the area in question this prevents trauma to the spinal cord during the removal of the tumor

The dura is incised well above and below the site of the tumor Small arachnoidal adhesions are freed and the tumor delivered, dividing the nerve fibers that are attached to the upper and lower margins.

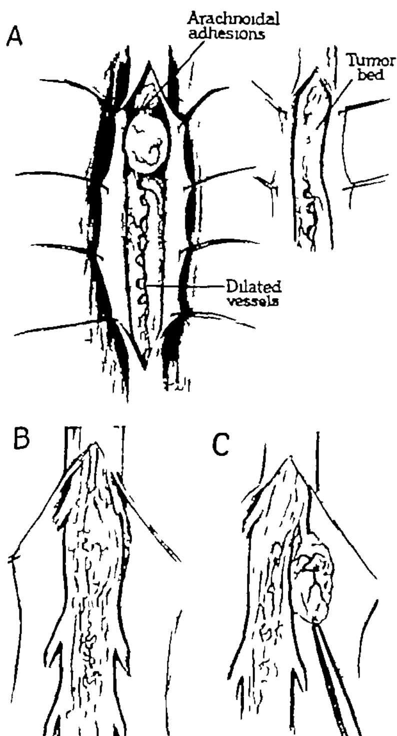
**B** Neurofibroma in the anterolateral portion. Posterior bulging of the spinal cord.

**C** If small, the tumor may usually be delivered from its bed.

Great care must be taken not to exert pressure on the spinal cord at the time of delivery

✓Removal of the lamina to the pedicle on the side where the tumor is to be delivered often *facilitates the operation.*

*(Continued on Plate 208)*


A
Arachnoidal adhesions
Tumor bed
Dilated vessels
B
C

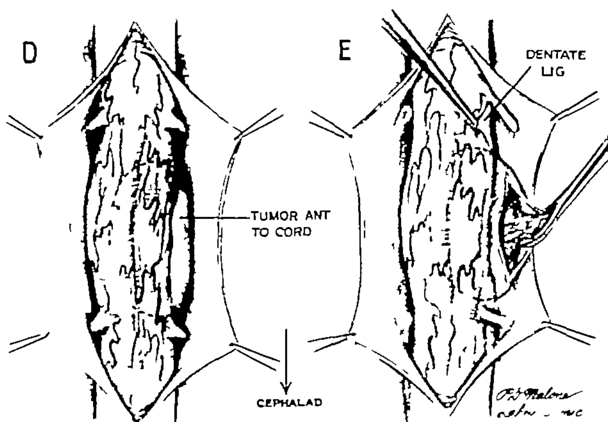
**D** Large neurofibroma anterolateral to the cord

In this particular instance delivery of the tumor without damaging the spinal cord is impossible.

**E** Dentate ligament divided spinal cord slightly rotated incision made in the capsule of the tumor and intracapsular evacuation performed.

This allows the capsule to be delivered without damage.

At times the tumor is completely obscured anterior to the cord, giving the impression that an intramedullary tumor is present. Dividing the dentate ligament is important, therefore, for thorough inspection of the anterior portion of the cord to ascertain that the tumor is extramedullary


D
E
DENTATE
LIG
TUMOR ANT
TO CORD
CEPHALAD

# DUMBBELL NEUROFIBROMA THORACIC REGION

**A** Patient in prone position outline of incision location of dumbbell tumor which arises intradurally and extends through the intervertebral foramen to the thoracic area.

**B** Cross section dumbbell neurofibroma.

(*Continued on Plates 210 to 212*)

# DUMBBELL NEUROFIBROMA THORACIC REGION

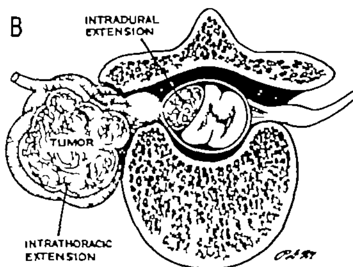
A

THORACIC EXTENSION OF TUMOR

INTRADURAL TUMOR

6
7
8
9

B



**C** Longissimus dorsi muscle divided through a slightly curved incision central portion of the incision is above the spinous processes located over the intradural portion of the tumor

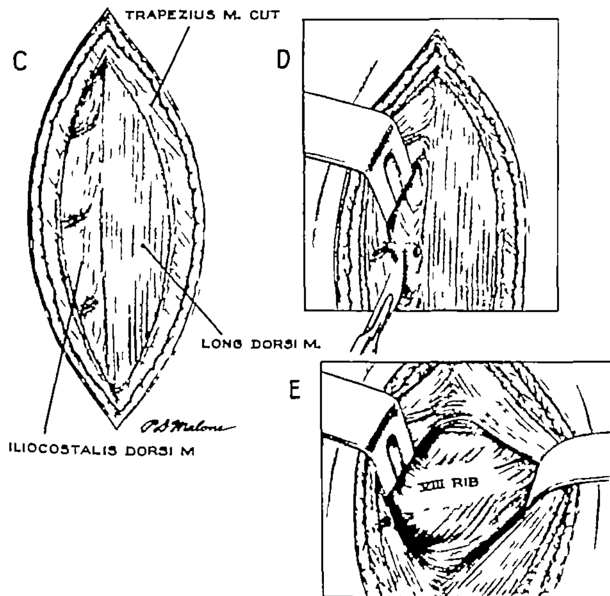
The line of cleavage between the iliocostalis dorsi and longissimus dorsi can always be determined by entering blood vessels

**D** Iliocostalis separated from the longissimus dorsi.

**E** Rib exposed and excised.

For technique of removal refer to Upper Thoracic Sympathectomy (Plates 181 and 182)

*(Continued on Plates 211 and 212)*

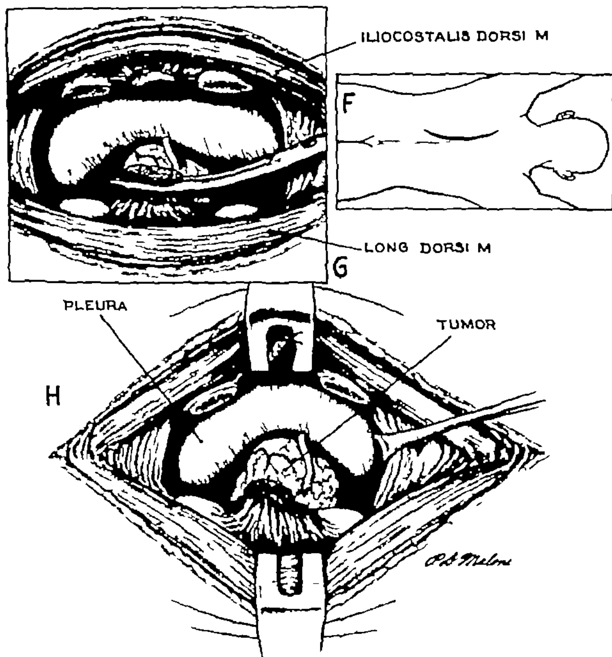

TRAPEZIUS M. CUT
C
D
LONG DORSI M.
E
VIII RIB
ILIOCOSTALIS DORSI M

**F** Position of patient relation of incision to spinal cord.

**G** Because of the size of the tumor after the intercostal muscle bundle has been divided sections of two ribs are removed medially to expose the parietal pleura and tumor

**H** The distal end of the intercostal nerve is divided and the pleura separated from the tumor

*(Continued on Plate 212)*


ILIOCOSTALIS DORSI M
F
LONG DORSI M
G
PLEURA
TUMOR
H

**I** Removal of tumor in the thoracic area.

**J** Laminectomy performed, dura opened and intradural portion of tumor exposed

**K** Tumor removed, leaving a fairly large dural opening.

The size of the opening depends entirely on the size of the tumor

**L** If the opening is small, the dura is sutured from the inside.

**M** If the opening is too large for simple suture, a dural graft is inserted

The dura is then closed in the usual manner Closure must be watertight to prevent fluid escaping into the thorax and causing a pseudo-intrathoracic arachnoid cyst.

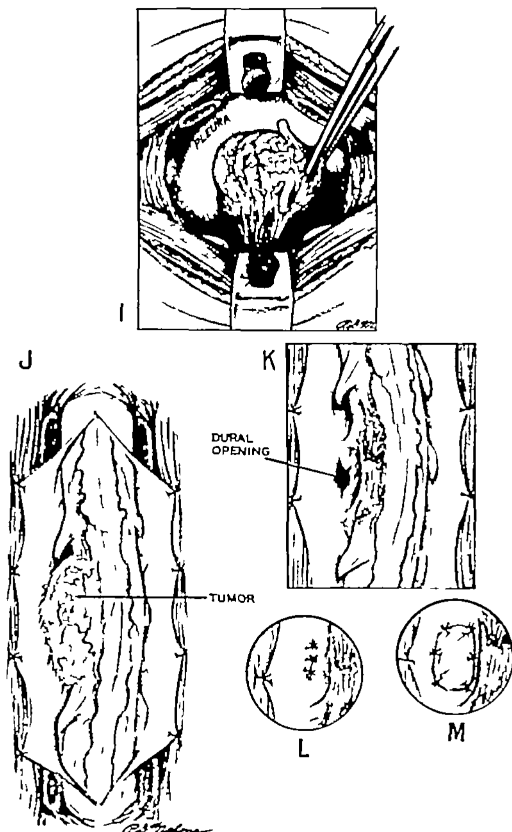



Plate 212

**A** Ependymoma emerging from the lower end of the spinal cord and extending into the spinal canal

It is important to perform an adequate laminectomy extending well above and below the site of the tumor At times the tumor can be removed in one segment. In some instances the tumor is soft and adheres to the strands of the cauda equina, thus requiring piecemeal removal. Care is taken not to injure the nerve fibers as the tumor is being removed

At times it is impossible to remove all the tumor cells. In these cases it is important to follow the operation with x-ray therapy

**B** Giant ependymoma extending from the conus medullaris into the sacral canal.

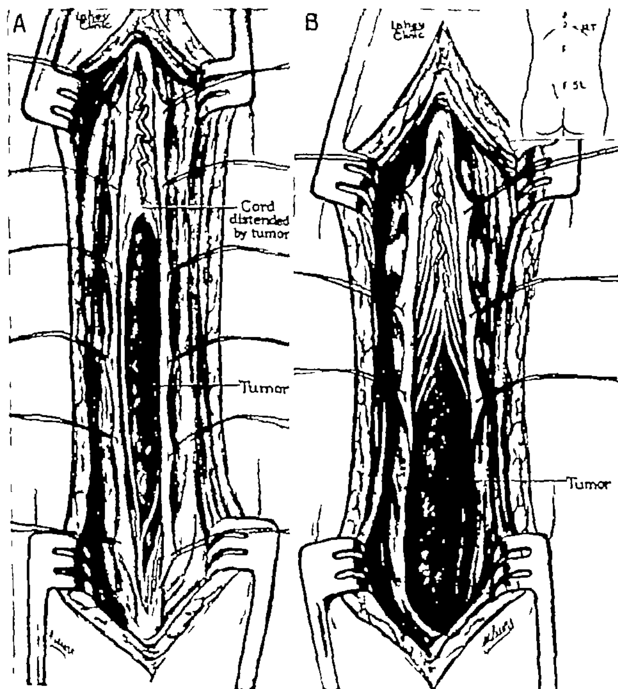



Plate 213

Epidural granulomas are usually quite extensive in length before compression of the cord takes place. Removal of the granuloma before complete paralysis occurs is important.

The operative sketch demonstrates an extensive laminectomy The granuloma is always extradural and can be peeled from the dura. Granulomas rarely extend anterior to the cord and lateral limits are usually at the level of the intervertebral foramina. Opening the dura after removal of the granuloma is unnecessary if normal pulsation takes place. The usual closure is made.

Following recovery from operation x ray therapy is instituted.

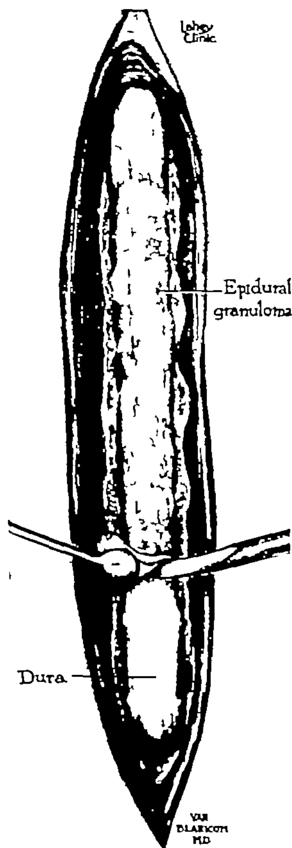
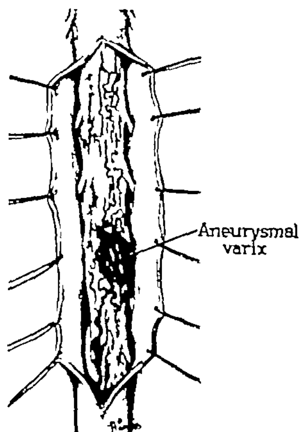



Plate 214

In most instances vascular anomalies are extensive and attempted removal can end only in catastrophe. For that reason, a wide laminectomy is performed The dura is opened, with the incision extending well above and below the involved cord and left widely open for decompression The usual accurate closure of soft tissues is made and x ray therapy is instituted at a later date.

In rare instances a small aneurysmal varix is uncovered, as shown. If lying superficially the varix may be first occluded by placing a silver clip above and below the sac and then excised. If abnormal vessels are seen above or below the site of the varix very little can be gained by removal of the varix and only decompression is indicated


Aneurysmal
varix

# SACROCOCCYGEAL TUMOR (CHORDOMA GIANT CELL TUMOR, SARCOMA)

The patient is placed in marked Fowler s prone position with thighs flexed.

**A** Incision over sacrum and coccyx in midline.

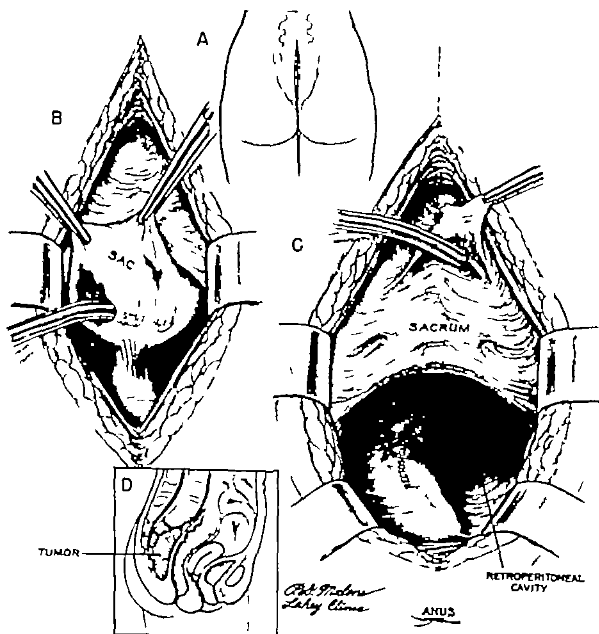
**B** Coccyx and lower portion of the sacrum removed. The retrorectal space is opened, exposing the tumor The tumor capsule is incised and an intracapsular enucleation performed by means of strong suction Capsule and laminae of the sacrum are removed.

**C** Tumor extending through the sacral foramina is removed by aspiration.

**D** Relation of tumor to rectosigmoid, coccyx and sacrum.

Catheter is placed in the cavity remaining after tumor is removed Closure is made with several layers of interrupted black silk sutures

SACROCOCCYGEAL TUMOR (CHORDOMA GIANT CELL TUMOR SARCOMA)



A Hemilaminectomy over most dependent portion of cyst

B Line of incision over most dependent portion of syrinx.

In most instances only the cyst capsule is present, with no vital cord tissue overlying it.

C Dependent portion of cyst more prominent anterior to nerve roots and dentate ligament as occurs occasionally

D Opening through which spinal needle can be readily inserted to aspirate cyst if fluid reaccumulates some months or years later this avoids reopening the incision.

E Fine spinal needle inserted into cyst fluid aspirated

F Acrylic tube inserted into most dependent portion of cyst lower end empties into subarachnoid space.

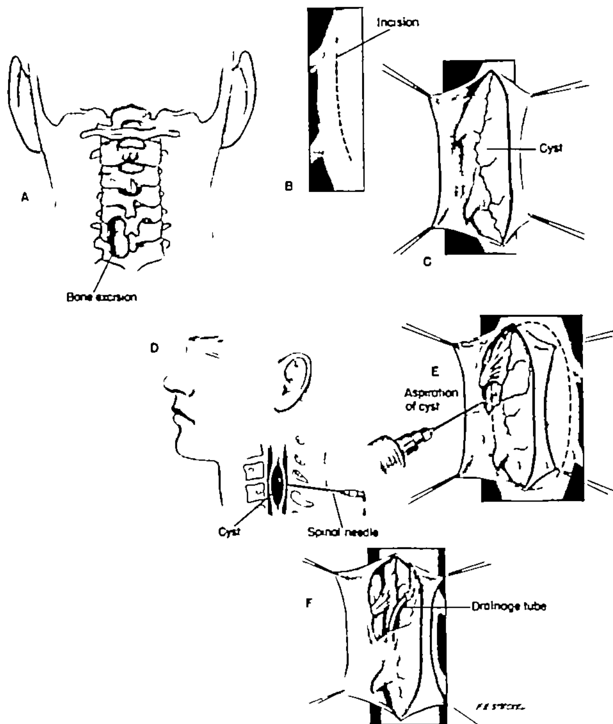

A
Bone excision
B
Incision
C
Cyst
D
Cyst
Spinal needle
E
Aspiration of cyst
F
Drainage tube

Plate 217

**A** Sitting position Herniation of tonsils through the foramen magnum with compression of the upper cervical cord

**B** Removal of bone through a midline incision extending from the inion to the fourth cervical spinous process. Wedging of tonsils into the upper cervical canal.

> It is not always necessary to remove the bone over both cerebellar hemispheres usually removal of the central portion of the occipital bone is sufficient, leaving the dorsal surface of bone over the foramen magnum where it has usually caused considerable constriction.

**C** Dura is opened widely keeping arachnoid intact.

> This prevents the rarely developing arachnoid pseudocyst in the line of incision at a later date.

**D** If hydromyelia of the upper cervical cord is present, the arachnoid must be opened tonsils delivered, and the hydromyelic cavity aspirated or opened.

> Unless the tonsils are severely scarred and bound down with dense adhesions, resection of the latter is not advisable.

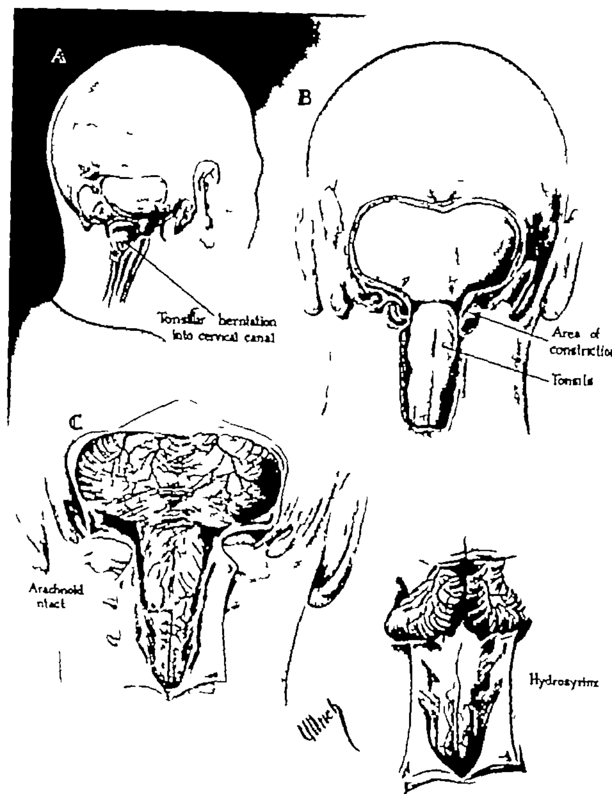
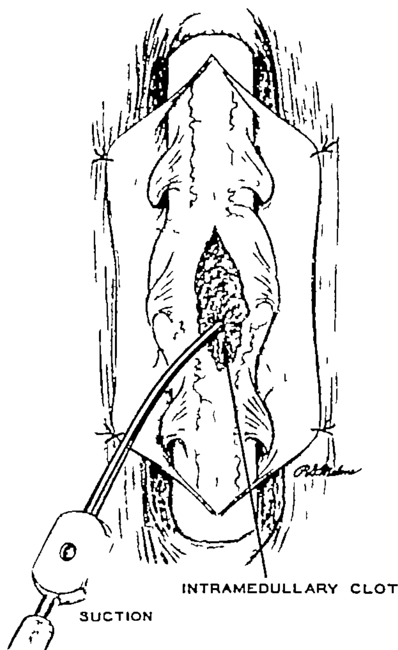

A
B
Tonsillar herniation into cervical canal
Area of constriction
Tonsils
C
Arachnoid intact
Hydrosyrinx

Plate 218

Fusiform enlargement of the spinal cord

The posterior median raphe has been incised and the intramedullary clot is being evacuated with suction.

Since considerable edema of the spinal cord is associated with the hematoma, post operative administration of urea solution, given intravenously for two or three days, is important.


INTRAMEDULLARY CLOT
SUCTION

**A** Prone position incision.

Incision should extend well above and below the area of the abscess.

**B** *Cross section compression of the dura and cauda equina by the abscess.*

**C** Laminectomy drainage of the abscess and removal of most portions of the granulation tissue.

**D** Gutta-percha applied to the depth of the incision on the left side, covering all of the soft tissue.

A similar film of gutta percha is placed on the right side.

**E** Gauze pack inserted between the layers of the gutta percha to allow adequate drainage and also to prevent premature closure of the incision

The incision is allowed to granulate in slowly from the inside to the outside. Secondary closure of the skin can be made at a later date.

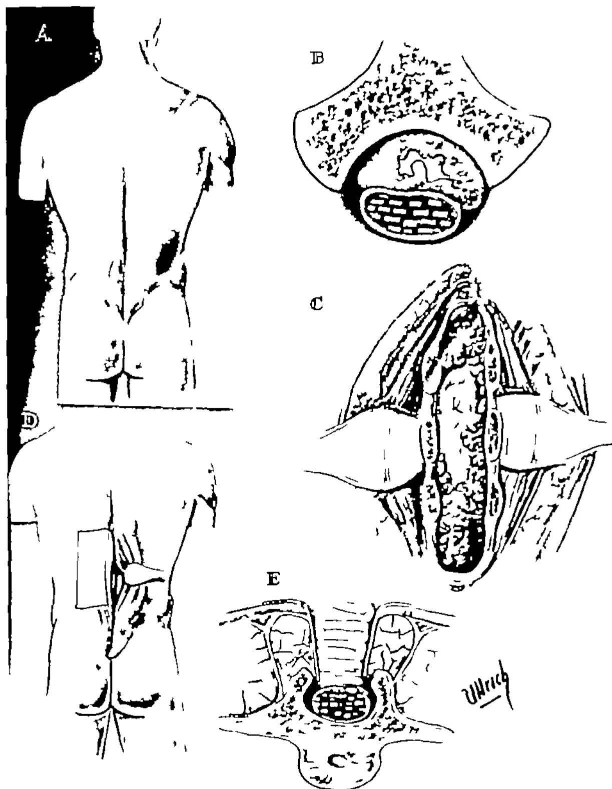
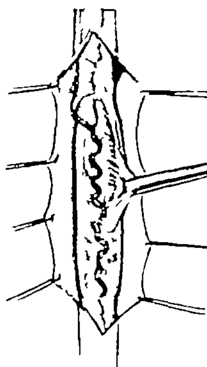



Plate 220

*Schematic drawing* Dense, thickened arachnoid.

As soon as the arachnoid which has constricted the cord is opened, the blood vessels dilate.

Unfortunately in most instances surgical intervention for arachnoiditis is unsuccessful in relieving the patient s symptoms.



**A** Site of incision.

**B** As much as possible of the healthy skin should be saved for closure after repair of the meningocele.

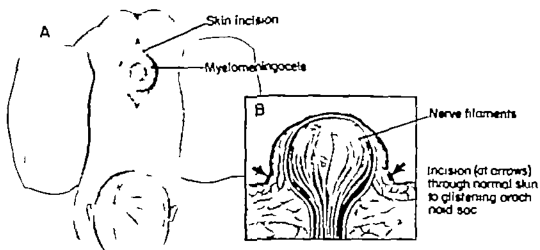
**C** Removal of the wedges of skin undermined to the neck of the meningocele.

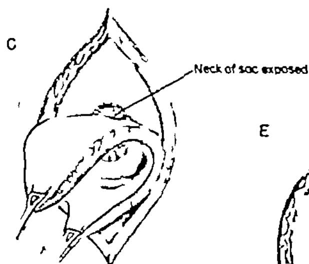
**D** Skin separated from the cyst, keeping the arachnoid intact

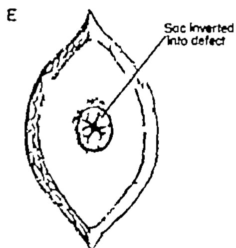
**E** Sac is inverted

*(Continued on Plate 223)*

# MYELOMENINGOCELE






F Skin margins are undermined for a considerable distance to allow skin closure and to expose the fascia over the paraspinous muscles

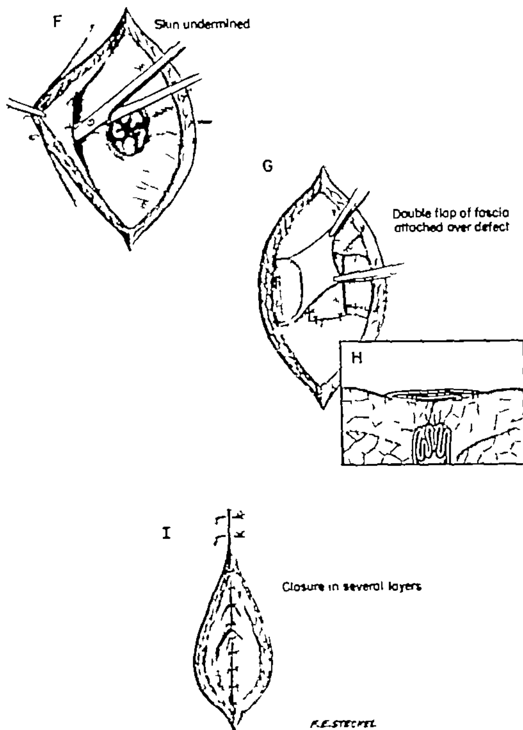
G Rectangular flap of fascia reflected medially from each side.

This tends to bring the muscles together as the two flaps are overlapped.

H Cross section closure.

I Reinforcing the area with multiple layers of interrupted black silk sutures is most important.

At times acute internal hydrocephalus may develop following the procedure. This should be combated either by ventricular drainage or by the use of intravenous urea solution. The internal hydrocephalus subsides in a few days.


F
Skin undermined
G
Double flap of fascia
attached over defect
H
I
Closure in several layers
F.E. STECHEL

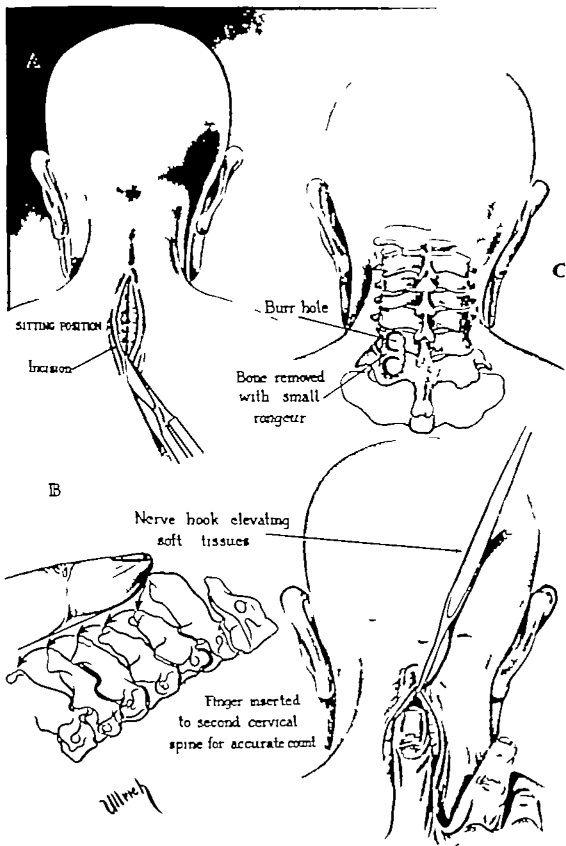
**A** Sitting position midline incision.

Exaggerated flexion of the head tends to tighten the paraspinous posterior cervical muscles, increasing the difficulty in traction.

**B** Method of accurately locating the proper cervical interspace which has previously been determined by myelography A nerve hook is inserted under the apex of the upepr portion of the incision and the index finger is inserted to the second cervical which is always the most prominent. The individual tips of the spinous processes may then be counted as the finger is brought downward.

**C** Burr openings made over the most lateral portion of the lamina above and below the location of the herniated disk

*(Continued on Plates 225 to 227)*


A
SITTING POSITION
Incision
Burr hole
Bone removed with small rongeur
C
B
Nerve hook elevating soft tissues
Finger inserted to second cervical spine for accurate count
Ullrich

# HERNIATED CERVICAL DISK (UNILATERAL)

**A** Sitting position midline incision

Exaggerated flexion of the head tends to tighten the paraspinous posterior cervical muscles, increasing the difficulty in traction.

**B** Method of accurately locating the proper cervical interspace which has previously been determined by myelography A nerve hook is inserted under the apex of the upepr portion of the incision and the index finger is inserted to the second cervical, which is always the most prominent. The individual tips of the spinous processes may then be counted as the finger is brought downward.

**C** Burr openings made over the most lateral portion of the lamina above and below the location of the herniated disk

*(Continued on Plates 225 to 227)*

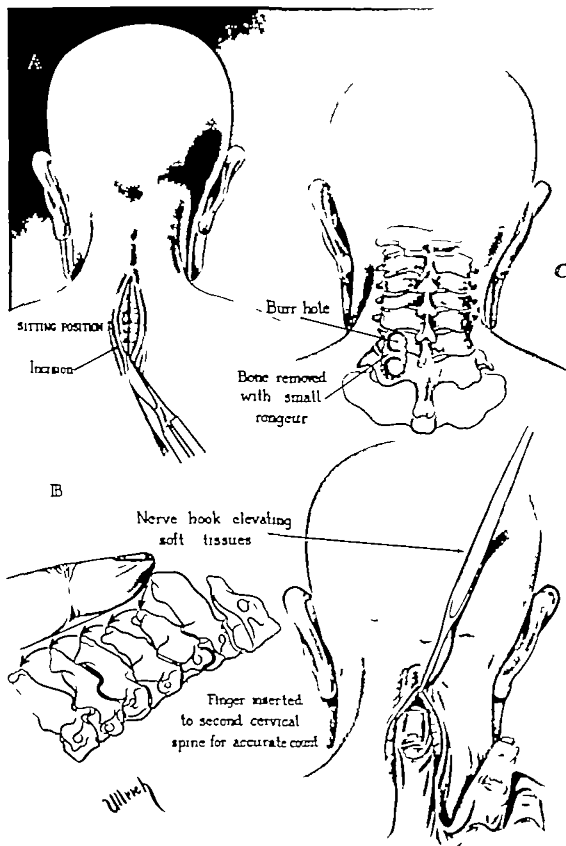

A
SITTING POSITION
Incision
Burr hole
C
Bone removed
with small
rongeur
B
Nerve hook elevating
soft tissues
Finger inserted
to second cervical
spine for accurate cord

Plate 224

D
E  After the soft tissues have been divided to the spinous processes, Hibbs retractors are inserted on each side of the spinous process and depressed.

F  Fascia may be separated with the electrosurgical knife from the spinous projection.

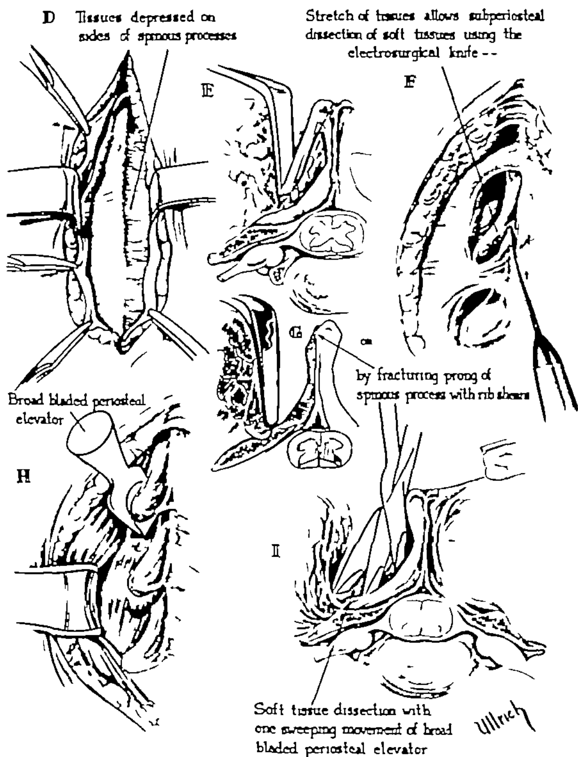
G  Rib shears may be used to fracture the unilateral prong from the bifid spinous process.

H  Subperiosteal dissection of tissues from spinous processes and lamina.

When the lateral prong of the spinous process is excised, the periosteal elevator may be inserted more easily and the tissues separated

I  Broad-based periosteal elevator dissecting the periosteum and muscle from each spinous process and lamina with one sweeping motion

*(Continued on Plates 226 and 227)*


D Tissues depressed on sides of spinous processes
Stretch of tissues allows subperiosteal dissection of soft tissues using the electrosurgical knife --
E
F
G
or
by fracturing prong of spinous process with rib shears
Broad bladed periosteal elevator
H
I
Soft tissue dissection with one sweeping movement of broad bladed periosteal elevator
Ullrich

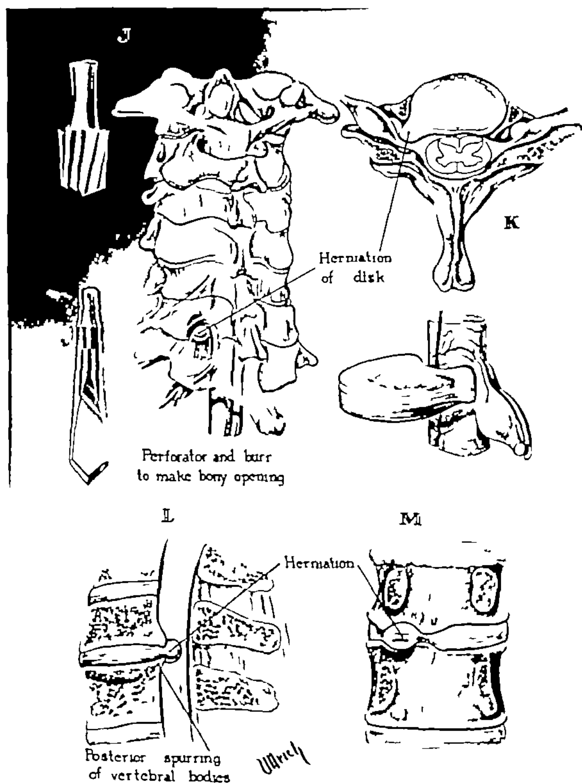
**J** Type of perforator and burr used. Opening made in lamina above and below the chosen interspace.

The perforator is used to simplify the insertion of the burr Care should be taken in using these instruments to avoid injury to the nerve root, which may be firmly compressed against the inferior portion of the lamina the ligamentum flavum should not be penetrated with either the perforator or the burr Bony openings may then be enlarged laterally with fine rongeurs.

**K** A simple rupture, without spurring.

**L**
**M** Posterior bone lipping or localized traumatic arthritic changes associated with the disk.

*(Continued on Plate 227)*


J
K
Herniation of disk
Perforator and burr to make bony opening
L
M
Herniation
Posterior spurring of vertebral bodies
Ullrich

**A** Patient placed in the prone position with maximum low back flexion. Short linear incision centered over the spinous processes of the intervertebral spaces involved.

**B** *Inferior portion of lamina removed*

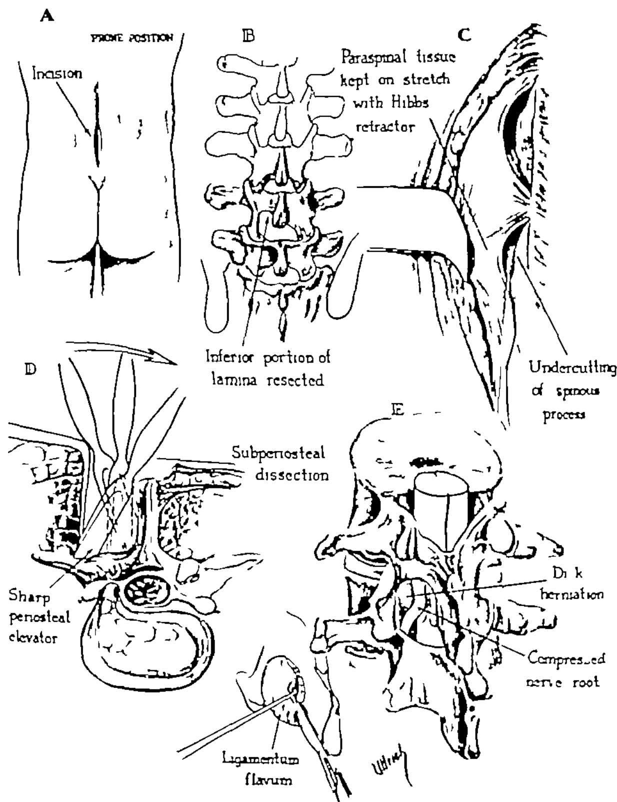
**C** Unilateral subperiosteal exposure of the lamina above and below the site of the ruptured cartilage. Soft tissues are retracted and depressed with a Hibbs deep-bladed retractor placing tension on tissues that are attached to these lumbar spinous processes

With this procedure, openings can be made in the fascia over the spinous processes and projections which are occasionally present in the lumbar area can be undercut.

**D** Tissues dissected subperiosteally and separated with a sweeping movement of a broad bladed, sharp periosteal elevator

**E** Ligamentum flavum raised with a dural hook and incised longitudinally near the midline.

(*Continued on Plates 229 and 230*)


A
PRONE POSITION
Incision
B
Paraspinal tissue
kept on stretch
with Hibbs
retractor
C
Inferior portion of
lamina resected
Undercutting
of spinous
process
D
E
Subperiosteal
dissection
Sharp
periosteal
elevator
Disk
herniation
Compressed
nerve root
Ligamentum
flavum

**A** Patient placed in the prone position with maximum low back flexion. Short linear incision centered over the spinous processes of the intervertebral spaces involved

**B** Inferior portion of lamina removed

**C** Unilateral subperiosteal exposure of the lamina above and below the site of the ruptured cartilage Soft tissues are retracted and depressed with a Hibbs deep-bladed retractor placing tension on tissues that are attached to these lumbar spinous processes.

With this procedure, openings can be made in the fascia over the spinous processes and projections which are occasionally present in the lumbar area can be undercut.

**D** Tissues dissected subperiosteally and separated with a sweeping movement of a broad-bladed sharp periosteal elevator

**E** Ligamentum flavum raised with a dural hook and incised longitudinally near the midline.

*(Continued on Plates 229 and 230)*

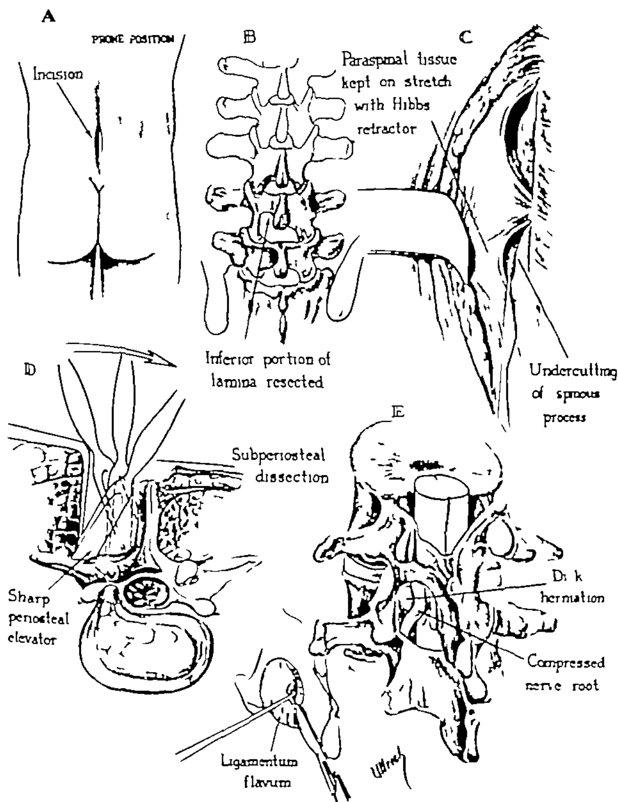

A
PRONE POSITION
Incision
B
Paraspinal tissue kept on stretch with Hibbs retractor
C
Inferior portion of lamina resected
Undercutting of spinous process
D
Subperiosteal dissection
Sharp periosteal elevator
E
Disk herniation
Compressed nerve root
Ligamentum flavum

Plate 228

# HERNIATED LUMBAR DISK (UNILATERAL)

**A** Patient placed in the prone position with maximum low back flexion Short linear incision centered over the spinous processes of the intervertebral spaces involved.

**B** Inferior portion of lamina removed

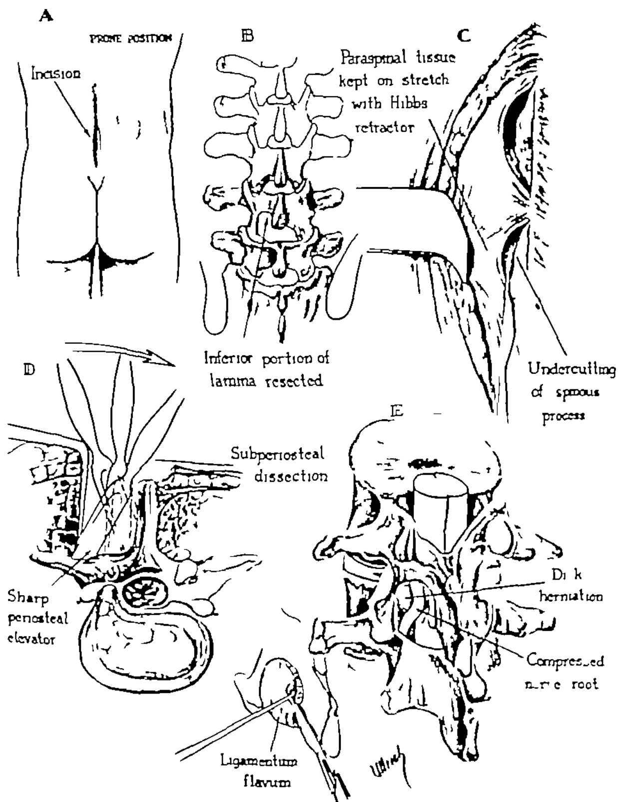
**C** Unilateral subperiosteal exposure of the lamina above and below the site of the ruptured cartilage. Soft tissues are retracted and depressed with a Hibbs deep-bladed retractor placing tension on tissues that are attached to these lumbar spinous processes

With this procedure, openings can be made in the fascia over the spinous processes and projections which are occasionally present in the lumbar area can be undercut.

**D** Tissues dissected subperiosteally and separated with a sweeping movement of a broad bladed, sharp periosteal elevator

**E** Ligamentum flavum raised with a dural hook and incised longitudinally near the midline.

*(Continued on Plates 229 and 230)*


A
PRONE POSITION
Incision
B
Paraspinal tissue
kept on stretch
with Hibbs
retractor
C
Inferior portion of
lamina resected
Undercutting
of spinous
process
D
Subperiosteal
dissection
Sharp
periosteal
elevator
E
Disk
herniation
Compressed
nerve root
Ligamentum
flavum

**F** Ligamentum flavum incised transversally along the superior margin of the caudad lamina and the inferior margin of the cephalad lamina.

> Because of considerable individual variation in normal thickness of the ligamentum flavum as well as variation in the thickness of the epidural fat, care must be taken not to enter the dura

**G** Free flap of the ligament pulled medially incised at the lateral margin, and carried into the space around the inferior facet. The attachment of the ligamentum flavum can then be separated with a small-bladed knife.

> More space is obtained when the ligament is removed in this manner since the thickness of the ligament (at times 2 to 4 mm.) may interfere with the exposure.

**H** After the ligament is removed, the posterior protruding ruptured cartilage can be readily felt by palpation with a forceps, or the nerve root can be seen displaced.

> In a few instances the ruptured cartilage has been unintentionally pushed back into its normal position between the bodies of the vertebrae or has receded spontaneously This is determined by the loss of normal resistance in the posterior longitudinal ligament immediately over the intervertebral space. The surgeon palpating with a forceps, has the impression that only the ligament lies across the space, with no cartilage beneath it
>
> Care is taken that the point of the forceps is inserted into the gutter of the spinal canal lateral to the nerve root, so that the latter can be readily displaced medially

**I** A cotton pledget attached to black silk is inserted snugly beneath the cephalad lamina lateral to the nerve root and extradurally A similar cotton pledget is inserted beneath the caudad lamina and the lateral gutter

> This accomplishes two purposes the pledgets occlude the epidural vein by pressure above and below the ruptured cartilage, thus avoiding brisk venous oozing they also tend to keep the nerve root and dural canal displaced medially

**J** The posterior longitudinal ligament, if not already ruptured, is incised in a rectangular or circular manner between the bodies of the vertebrae. As soon as this has been done, the degenerating cartilage protrudes and at times practically delivers itself. The protruding portion is grasped with pituitary rongeurs and gently teased from the interspace.

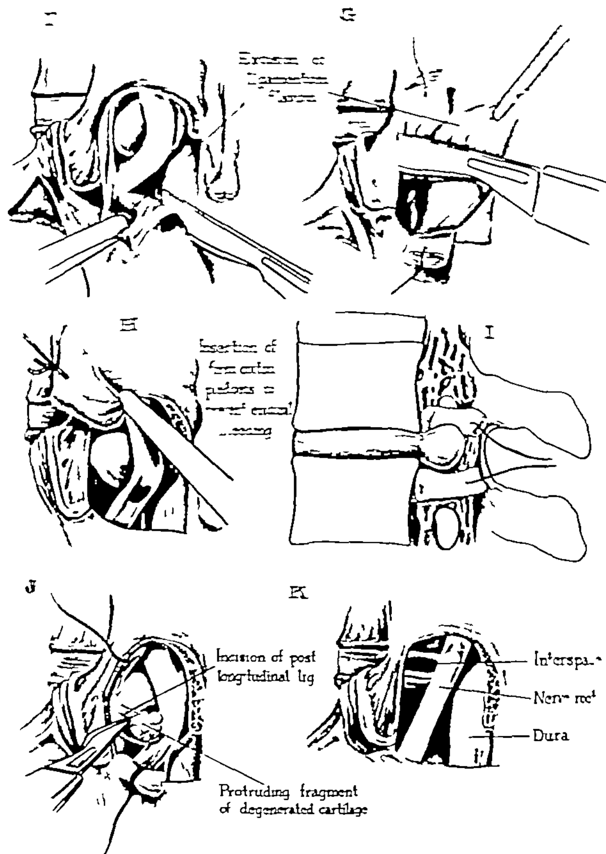
> At times the entire degenerated portion lies free and is delivered in one large fragmented piece at other times the torn fragments must be removed piecemeal. With use of the pituitary rongeurs, which have a slight angle, the degenerated portion of cartilage can be removed through a unilateral approach.

**K** Degenerated cartilage removed.

> To avoid future herniation, the entire degenerated portion of the cartilage must be removed. In a few patients a definite spurring of the bodies of the vertebrae posteriorly is associated with a ruptured cartilage (refer to Herniated Cervical Disks, Plate 227). Even though the degenerated portion of the disk has been adequately removed, the nerve root is impinged by the proliferation of bone which in reality is a localized traumatic arthritis. These spurs are removed with a chisel as shown in operation for Herniated Cervical Disk.

*(Continued on Plate 230)*

# HERNIATED LUMBAR DISK (UNILATERAL)



**L** Closure of the subcuticular tissues.

**M** Type of suture used to prevent dead space and collection of serum

**N** Skin closure.

**O** Dressing.

**P** Straight leg maneuver

This is performed immediately following surgery while the patient is still under the influence of the anesthetic agent, in order that the finer adhesions which may have developed in the nerve roots may be released and complete relief from pain hastened This is especially valuable in patients who have had severe sciatica for a long period of time

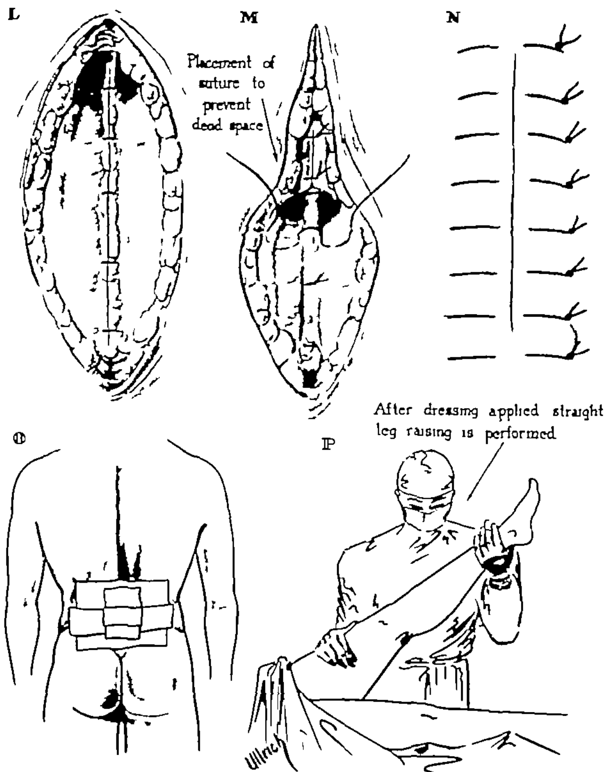

L
M
N
Placement of suture to prevent dead space
O
P
After dressing applied straight leg raising is performed
Ullrich

Plate 230

# HERNIATED LUMBAR DISK (CENTRALLY PLACED)

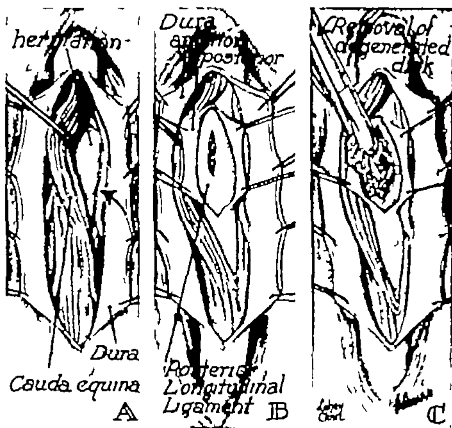
At times a ruptured intervertebral disk is extruded centrally If removal of the disk through a hemilaminectomy seems impossible without causing undue pressure on a nerve root, a transdural exposure should be made.

**A** Dura open bulging of the anterior dura, and enlargement of the nerve root with tiny adhesions.

**B** Dura opened and anterior longitudinal ligament incised.

**C** Fragmented extruded cartilage removed anterior and dorsal dura closed.

This procedure is necessary only in rare instances but is valuable for patients in whom the extra dural approach is impossible.


Dura
Cauda equina
A
Dura
B
C

# INTRACTABLE PAIN CORDOTOMY

Cordotomy for intractable pain in the lower extremities resulting from metastatic carcinoma or primary malignancy is usually performed in the upper thoracic area however the site of cordotomy varies with the location of the discomfort.

A Lamina and spinous processes of the third and fourth thoracic vertebrae are removed. If an overhanging spinous process is present in the upper portion, this should be removed, as indicated by the shaded area.

B Dura opened widely

C Edges of dura are tacked to the muscle for retraction. The dentate ligament is divided on each side at the level of the cordotomy allowing the cord to be gently rotated

*(Continued on Plate 233)*

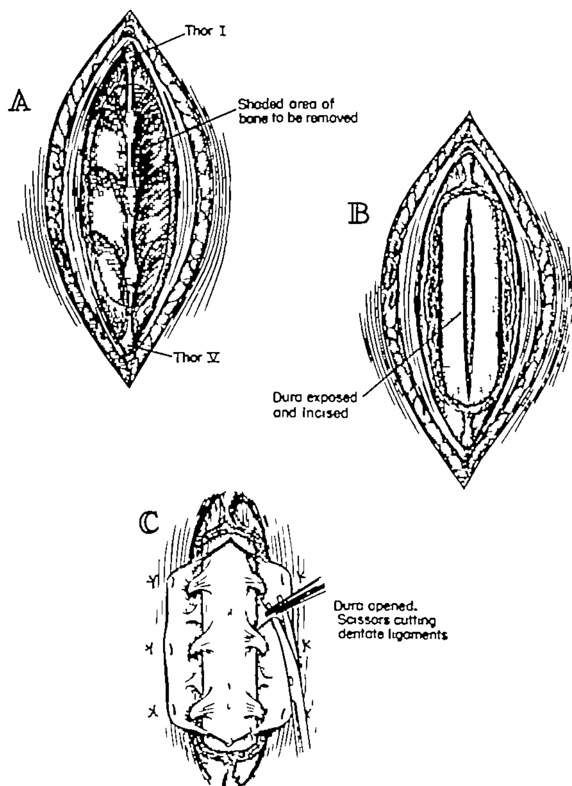

A
Thor I
Shaded area of
bone to be removed
Thor V
B
Dura exposed
and incised
C
Dura opened.
Scissors cutting
dentate ligaments

Plate 232

Cordotomy for intractable pain in the lower extremities resulting from metastatic carcinoma or primary malignancy is usually performed in the upper thoracic area however the site of cordotomy varies with the location of the discomfort.

**A** Lamina and spinous processes of the third and fourth thoracic vertebrae are removed. If an overhanging spinous process is present in the upper portion this should be removed, as indicated by the shaded area.

**B** Dura opened widely

**C** Edges of dura are tacked to the muscle for retraction The dentate ligament is divided on each side at the level of the cordotomy allowing the cord to be gently rotated.

*(Continued on Plate 233)*

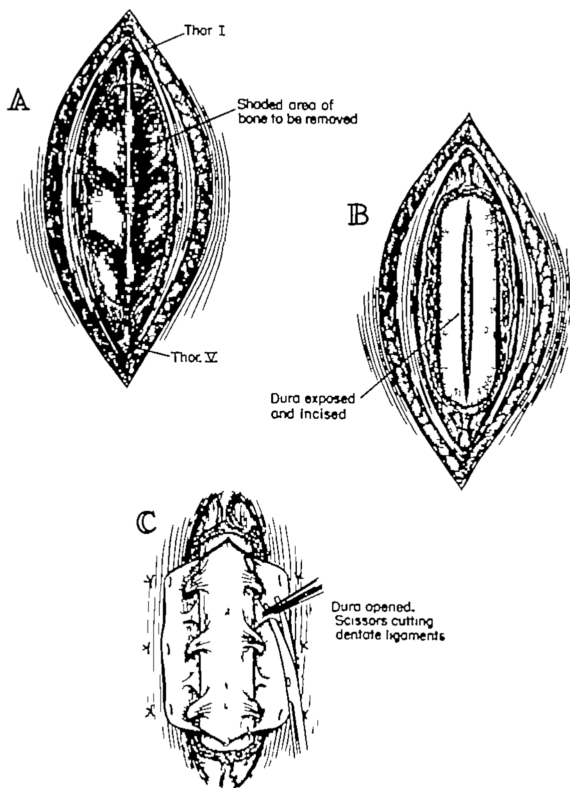

A
Thor I
Shaded area of
bone to be removed
Thor. V
B
Dura exposed
and incised
C
Dura opened.
Scissors cutting
dentate ligaments

Plate 232

**D** Posterior roots above and below the area of incision in the anterior portion of the cord are divided.

This helps prevent the painful hyperesthesia that may develop postoperatively from traction on the posterior roots.

A cotton pledget is inserted lateral to the spinal cord By simultaneously exerting very slight pressure on the cotton pledget and elevating the spinal cord by the dentate ligament opposite, the entire anterior quadrant of the cord is readily visualized. Incision with a sharp-pointed knife is started immediately beneath the attachment of the dentate ligament and the entire quadrant is divided, care being taken to prevent injury to the anterior spinal artery

**E** Rotation of the spinal cord and incision of the entire anterior quadrant.

**F** Bilateral cordotomy

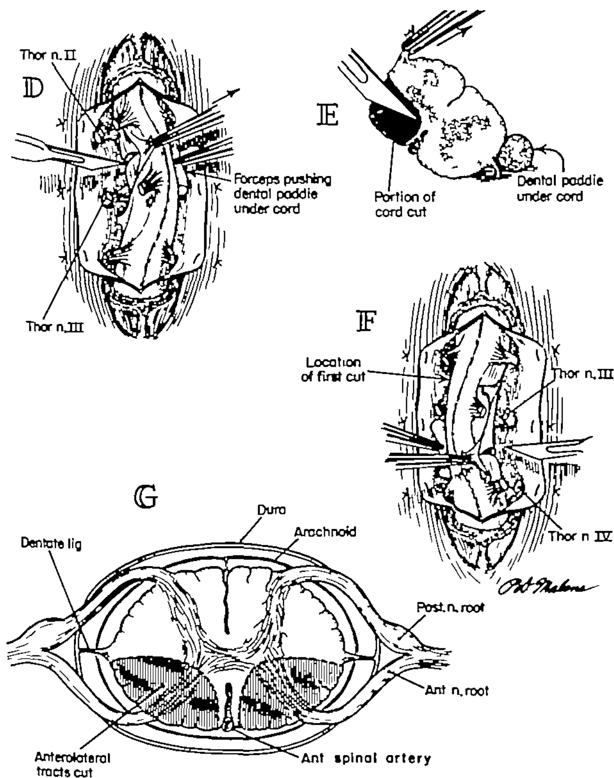
When bilateral cordotomy is necessary our policy has been to wait a week or ten days before performing the cordotomy on the opposite side.

The incision is then reopened and the cordotomy made one segment below the level of the previous cordotomy

If the patient has definite bladder incontinence from the original malignancy the bilateral cordotomy may be performed in one stage. A two-stage operation with an interval of seven to ten days between stages tends to prevent permanent bladder dysfunction

**G** Cross section of the cord with the anterolateral tracts cut.

The tracts should be divided as close to the midline as is possible without injuring the anterior spinal artery


D
Thor n. II
Forceps pushing dental paddle under cord
Thor n. III
E
Portion of cord cut
Dental paddle under cord
F
Location of first cut
Thor n. III
Thor n. IV
G
Dura
Arachnoid
Dentate lig
Post. n. root
Ant n. root
Anterolateral tracts cut
Ant spinal artery

The usual exposure is made as demonstrated in the technique for laminectomy The number of laminae to be removed depends on the extent of the segments to be divided Unilateral laminectomy is sufficient if the pain is on one side.

A Incision for dorsal rhizotomy

B Normal relationship of structures.

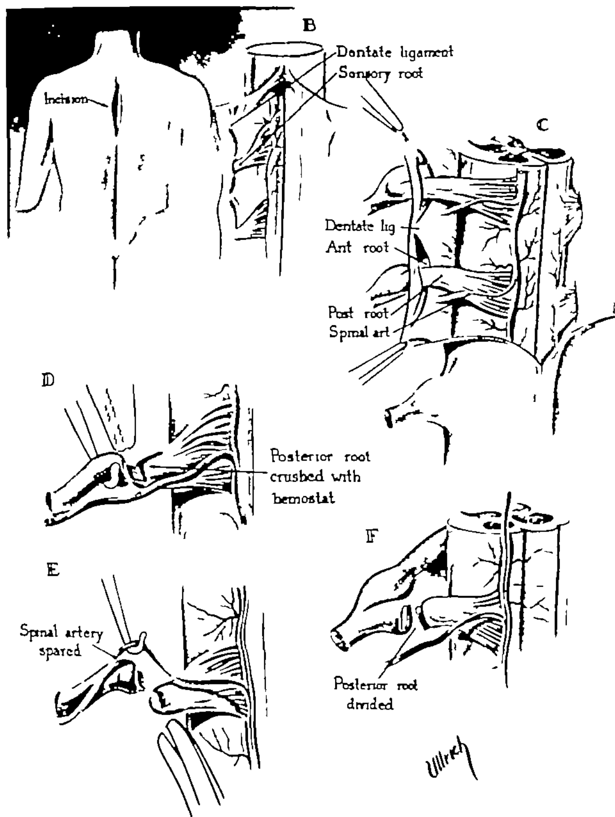
C Posterior root easily distinguished from anterior root since it lies dorsal to the dentate ligament.

D Posterior root carefully seperated from the artery This is most important to prevent ischemia of the spinal cord if extensive rhizotomy is contemplated. Root crushed with hemotstat.

E Spinal artery preserved.

F Posterior root divided with scissors or scalpel.

The soft tissues are closed with interrupted layers of black silk or stainless steel wire. Stainless steel wire is of particular value if the laminectomy is performed in the upper thoracic region


B
Dentate ligament
Sensory root
Incision
C
Dentate lig
Ant root
Post root
Spinal art
D
Posterior root
crushed with
hemostat
E
Spinal artery
spared
F
Posterior root
divided

The usual exposure is made as demonstrated in the technique for laminectomy The number of laminae to be removed depends on the extent of the segments to be divided Unilateral laminectomy is sufficient if the pain is on one side.

**A** Incision for dorsal rhizotomy

**B** Normal relationship of structures.

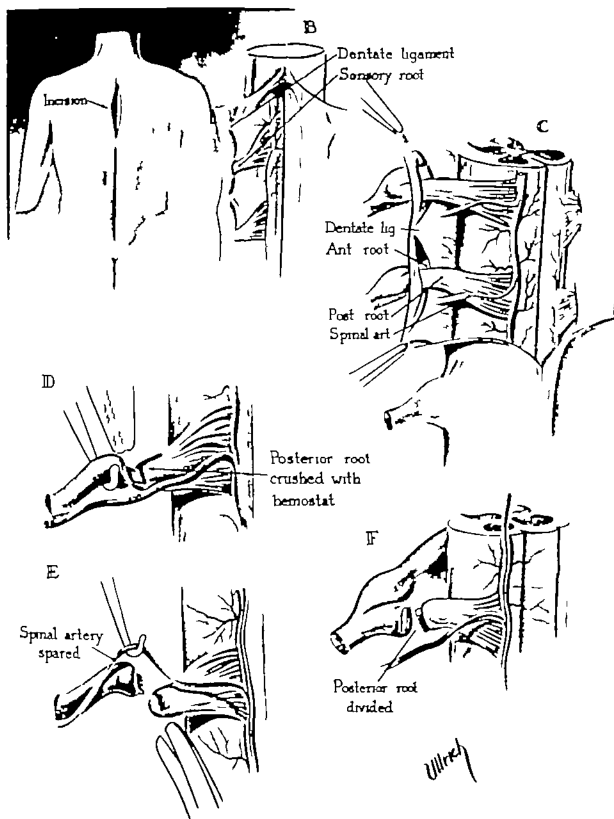
**C** Posterior root easily distinguished from anterior root since it lies dorsal to the dentate ligament.

**D** Posterior root carefully separated from the artery This is most important to prevent ischemia of the spinal cord if extensive rhizotomy is contemplated Root crushed with hemotstat.

**E** Spinal artery preserved.

**F** Posterior root divided with scissors or scalpel.

The soft tissues are closed with interrupted layers of black silk or stainless steel wire. Stainless steel wire is of particular value if the laminectomy is performed in the upper thoracic region.


B
Dentate ligament
Sensory root
Incision
C
Dentate lig
Ant root
Post root
Spinal art
D
Posterior root
crushed with
hemostat
E
Spinal artery
spared
F
Posterior root
divided
Ullrich

# Part VI NEUROSURGICAL DIAGNOSIS

**A** Side view of position of the head.

**B** Posterior view The incision is 3 0 to 3.5 cm. from the midline, and approximately 7 0 cm above the level of the inion

In most instances the patient has been anesthetized previous to ventriculography and procaine (Novocain) injection is not necessary

**C** Burr opening made through a small incision. Edges of the scalp are kept separate with a small self retaining retractor

*(Continued on Plates 236 and 237)*

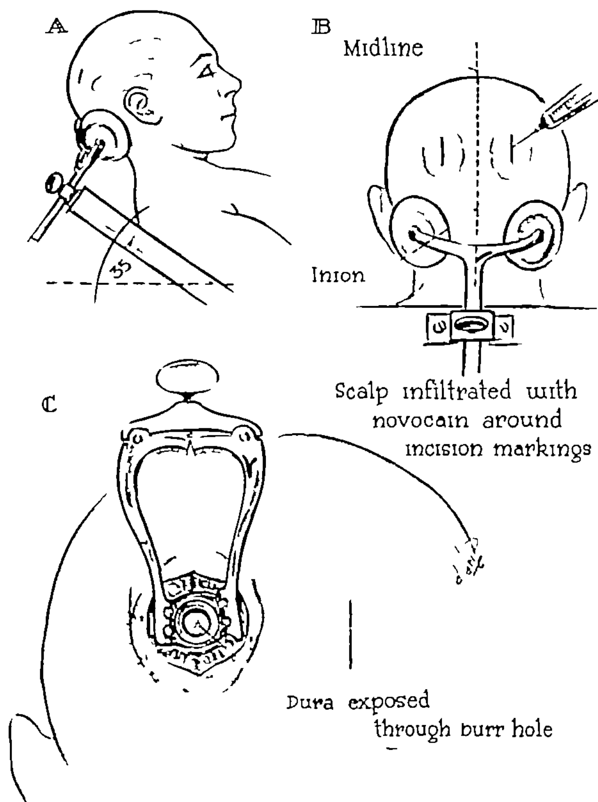

A
B
Midline
Inion
35
Scalp infiltrated with novocain around incision markings
C
Dura exposed through burr hole

Plate 235

**D** Dura incised by elevation with a fine dural hook.

**E** Incision enlarged edges readily retracted with light coagulation A sharp-pointed needle is then inserted through the arachnoid only to allow insertion of the ventricular needle.

**F** Larger cortical veins are usually visible through the dura. If the larger vein traverses the burr opening in its lower margin the dura is opened above to avoid inadvertently opening the vein at the time of dural incision.

**G** At times an aberrant lateral sinus is found immediately beneath the burr opening it can usually be recognized by the bluish cast of the dura.

**H** Burr opening enlarged with rongeur and dura opened lateral to it

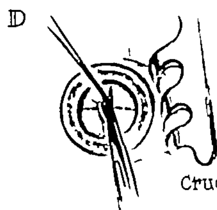
After the dura is opened, the cortex must be inspected for signs of increased pressure.

**I** In this particular instance, the cortex is normal with the sulci of the convolutions of nor mal width.

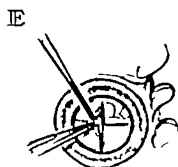
**J** Bulging of the cortex and narrowing of the sulci.

*(Continued on Plate 237)*

D



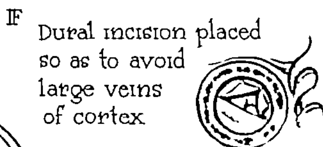
E



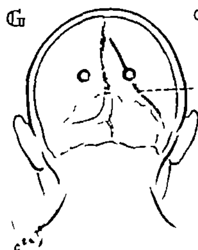
Cruciate incision of dura

F

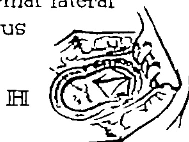
Dural incision placed so as to avoid large veins of cortex



G



Abnormal lateral sinus



H

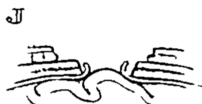
Bone excision extended with rongeur to avoid abnormal sinus

I



Normal appearing cortex

J



Under pressure from tumor cortex bulges when dura is incised

K The left hand is placed over the vertex of the skull, with the middle finger on the bregma and the thumb as shown. The needle is then inserted into the right ventricle through the small opening made in the arachnoid.

L Relation of the needle to the ventricle and the bony opening.

The needle is usually directed toward the upper portion of the eyeball on the side the puncture is made. A ventricular needle is also inserted into the left ventricle. As soon as the ventricle has been entered initially on one side, it is usually preferable to withdraw the needle slightly so that no fluid escapes. A second needle is then inserted into the opposite ventricle, preventing collapse.

M Incision closed with two layers of black silk. Type of suture used to retain catheter which has been inserted through the opening made by the ventricular needle.

Catheter is allowed to remain *in situ* during the operation to permit drainage, and also postoperatively for twenty four to forty-eight hours.

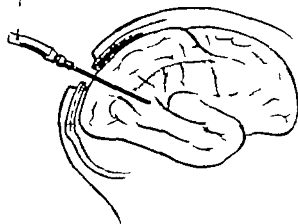
N Type of rubber bag and pet cock attached to catheter for closed drainage.

K

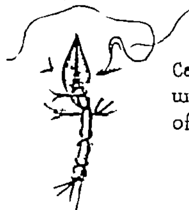
Cannula inserted parallel to midline

L

1½ long rubber tube



M



Catheter tied in with closure of scalp

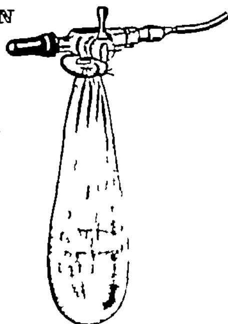


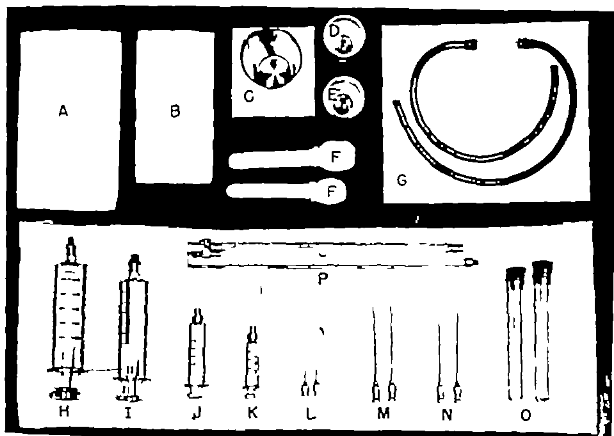

Plate 237

Air studies via the lumbar route are carried out in the x ray department under light Pentothal anesthesia.

Necessary equipment for introduction of air

(*Continued on Plates 239 to 241*)

# ENCEPHALOGRAPHY




ENCEPHALOGRAPHY

A. Towels

B Sponges

C Cup for tincture of Zephiran

D Cup for 1/ procaine

E Cup for spinal fluid

F Swabs

G Tubing (from oxygen tank)

H. 30 cc syringe

I 20 cc syringe

J 5 cc. syringe

K 2 cc. syringe

L. 26 gauge hypodermic needles

M 18 gauge spinal needles

N 20 gauge spinal needles

O Test tubes

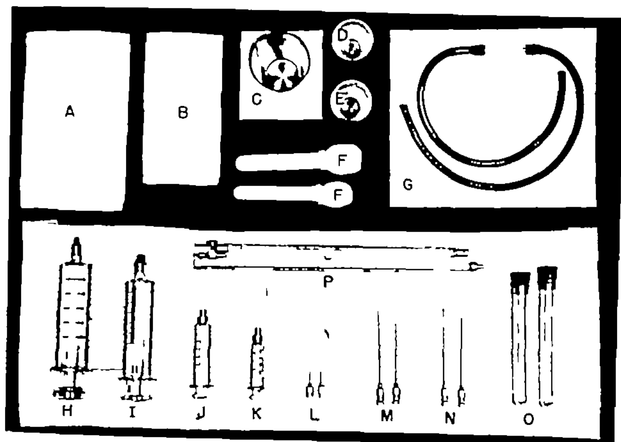
P Spinal manometers with pet cock

Plate 238

Air studies via the lumbar route are carried out in the x ray department under light Pentothal anesthesia.

Necessary equipment for introduction of air

(*Continued on Plates 239 to 241*)




ENCEPHALOGRAPHY

A. Towels

B Sponges

C. Cup for tincture of Zephiran

D Cup for 1% procaine

E Cup for spinal fluid

F Swabs

G Tubing (from oxygen tank)

H 30 cc. syringe

I 20 cc syringe

J 5 cc. syringe

K 2 cc. syringe

L 26 gauge hypodermic needles

M 18 gauge spinal needles

N 20 gauge spinal needles

O Test tubes

P Spinal manometers with pet cock

Plate 238

Patient in a sitting position, supported by adjustable chest and chin bars attached to the side of the x ray table.

(*Continued on Plates 240 and 241*)


F.E.S.

Local infiltration of skin with procaine at either the third or fourth lumbar space.

This allows the 18 gauge spinal needle to be introduced into the subarachnoid space with the patient under light intravenous Pentothal anesthesia. Oxygen or air 15 to 20 cc., is introduced with moderate speed into the subarachnoid space without allowing spinal fluid to escape before the injection

*(Continued on Plate 241)*



With the patient s head slightly flexed, the oxygen usually fills the fourth ventricle and aqueduct of Sylvius in five seconds. Suitable lateral and posteroanterior films are taken immediately

The needle is then withdrawn, the patient is placed in the prone position and the routine stereoscopic x ray exposures are made. These include the single anteroposterior posteroanterior views, the right and left lateral views and the brow up and down single views.

*If no fluid is allowed to escape, patients tend to have fewer headaches following encepha* lography and the ventricular filling is more constant. In some instances it may be advantageous to displace most of the cerebrospinal fluid with air or oxygen as in post traumatic syndromes and degenerative diseases If so, the fluid is allowed to escape in amounts of 5 to 10 cc. and is replaced with air



Plate 241

**A** Midline incision about 2.5 cm. in length made in the scalp over the sagittal sinus just anterior to the coronal suture.

**B** Scalp edge reflected and burr opening made over the central portion of the sagittal sinus.

**C** Dural hook inserted into the dorsal roof of the sinus and elevated a small incision is made into the sinus.

**D** Catheter inserted, either anterior or posterior

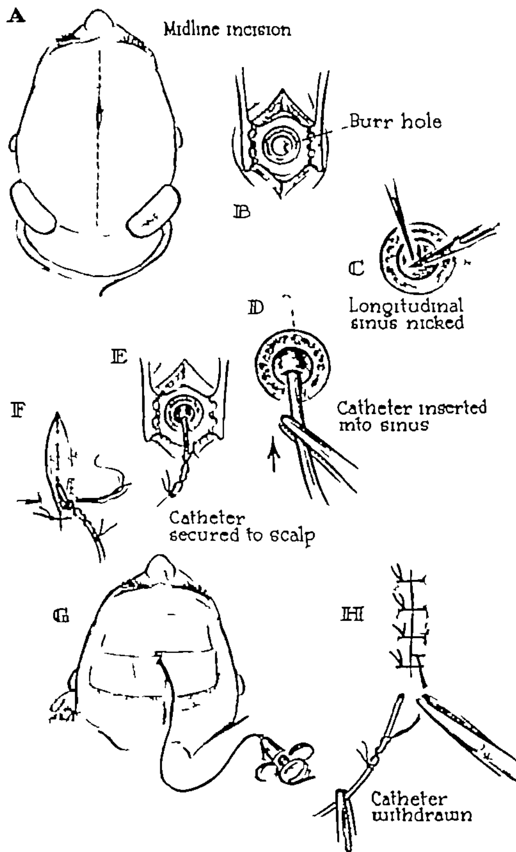
**E** Catheter sutured to scalp

**F** Incision sutured with two layers of interrupted black silk.

**G** Dressing applied A syringe is attached to the catheter and Hypaque or Renografin is injected

Roentgenograms are taken during the injection

**H** Pressure exerted over the dressing retaining suture divided and catheter removed.


A
Midline incision
B
Burr hole
C
Longitudinal sinus nicked
D
E
Catheter inserted into sinus
F
Catheter secured to scalp
G
H
Catheter withdrawn

The technique of percutaneous arteriography is simple. The completion of a satisfactory arteriogram depends upon the teamwork of the operator and the x ray technician and upon the physical equipment—namely the x ray apparatus, syringe and needle, which must be in perfect working order

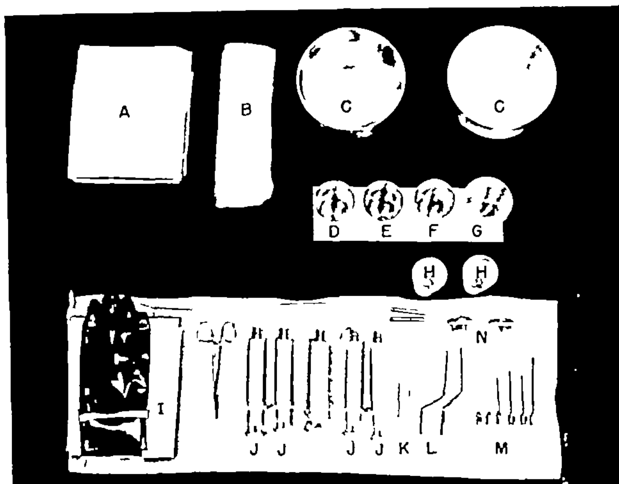
The patient is allowed to remain on the carrier stretcher and is transported to the x ray department. The wheels of the carriage are firmly fixed so that no motion can occur at the time of injection Anesthesia is introduced with intravenous Pentothal.

Care must be exercised to prevent overextension of the patient s neck. It would seem probable that by extension of the neck the large vessels would be held under stretch, thus allowing the needle to enter the lumen more readily The opposite, however has been my experience. The lumen of the artery is actually narrowed and may in some instances be occluded by the stretch over the tubercle of the sixth cervical vertebra The only possible exception is the younger patient in whom the arteries are excessively mobile.

It is important to take frequent blood pressure readings. Contrast medium should not be injected if the blood pressure is materially lowered from the normal or if the patient is anoxemic.

Equipment necessary for introducing contrast medium (Hypaque or Renografin) into the carotid or vertebral arteries An 18 gauge needle with a very sharp point and a moderately curved bevel attached to a 10 cc. Luer Lok syringe by a two-way pet cock is used.

*(Continued on Plates 244 to 246)*




PERCUTANEOUS ARTERIOGRAPHY

A Towels for draping

B Sponges

C Basins with saline (for rinsing syringes)

D Cup with tincture of Zephiran

E Cup with 70% alcohol

F Extra cup

G 2.5% sodium citrate

H Medicine glasses with Hypaque or Renografin

I Gloves with hand towel

J 10 cc. syringe

K 2 cc. syringe

L Curved arteriogram needles

M Assorted straight needles 26 to 18 gauge

N Two-way pet cocks

**A** Positions of the middle finger over the carotid bulb and the index finger over the common carotid artery The point of the needle has engaged the adventitia and is placed at dead center

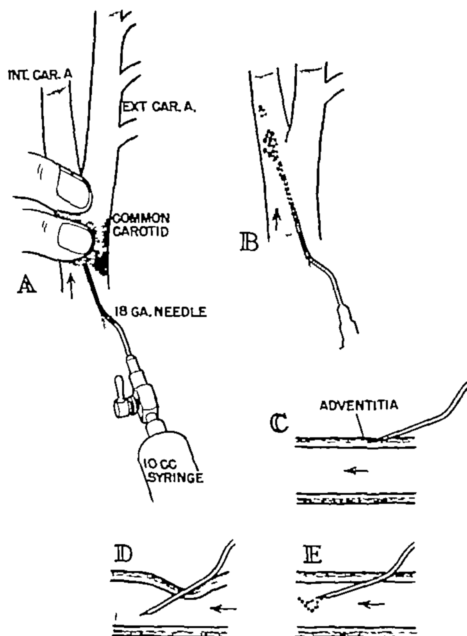
**B** Needle in the lumen of the common carotid artery with the bevel pointing laterally toward the lumen of the internal carotid artery

**C** Schematic drawing of the point of the needle in the adventitia.

**D** The quick thrust of the needle through the wall.

**E** Needle in correct position

*(Continued on Plates 245 and 246)*


INT. CAR. A
EXT CAR. A.
COMMON CAROTID
A
18 GA. NEEDLE
10 CC SYRINGE
B
ADVENTITIA
C
D
E

The patient's head is allowed to remain in a horizontal plane. The index and middle fingers of the left hand are used to palpate the common carotid artery. The middle finger is placed on the carotid bulb and the index finger on the common carotid artery. The needle is inserted through the skin 1 or 2 cm. above the clavicle and directed cephalad so that the point of the needle engages the adventitia of the common carotid artery immediately beneath the site of the index finger. Delicate pressure is then exerted on the needle with the syringe. The pressure is immediately released if there is any tendency for the artery to roll to one side since this indicates that the point of the needle is engaged eccentrically and not at dead center.

As soon as the operator is certain that the needle is dead center over the artery and that the *point is engaged in the adventitia (which must be determined entirely by the feel of the index* finger of the left hand and by the sensation transmitted through the needle and syringe to the right hand) the needle may be inserted into the artery by a quick thrust.

(*Continued on Plate 246*)



Plate 245

The left hand is firmly placed over the clavicle, holding the hub of the needle at its attachment to the pet cock. At this time the operator must be certain that the needle is well engaged in the lumen of the artery and will not be displaced by the injection It is wise to take several practice injections with citrate solution, which is used to prevent clotting of blood in the syringe and needle. If several cubic centimeters can be injected rapidly and a free backflow of arterial blood occurs with the needle directed toward the lateral wall of the common carotid artery the state is set for the actual injection of the contrast medium. If the arteriogram is to be performed for an aneurysm, 5 cc is usually sufficient for tumors [illegible] cc is preferable

Great care must be exercised to prevent bubbles of air which become caught in the hub of the needle as the syringe is attached, from being injected into the carotid system To prevent this blood is allowed to flow into the contrast medium so that two or three bubbles of air will be carried to the upper portion of the syringe and remain there during the injection.

> A word of caution should be inserted here the operator and assistant must be careful not to allow themselves to be exposed to radiation beyond the dosage that is safe.

Percutaneous arteriography of the vertebral system is accomplished by inserting the tip of the needle at the level of the cricothyroid cartilage, displacing the carotid artery laterally and introducing the needle at the level of the third or fourth cervical intervertebral foramen. The reason for introducing the needle at this level rather than at the fifth cervical foramen is to prevent a temporary neuritis that may develop in the brachial plexus from irritation of the nerve trunks.



Plate 246

# TURKEL BONE BIOPSY OF SKULL

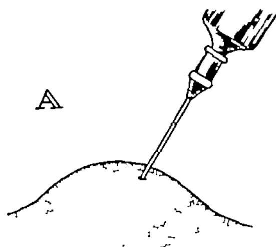
**A** Small area of scalp over the lesion is prepared by shaving and infiltrated locally with procaine.

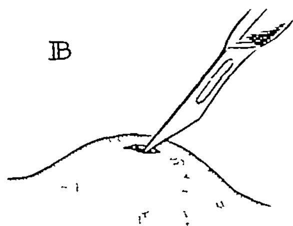
**B** Small stab incision.

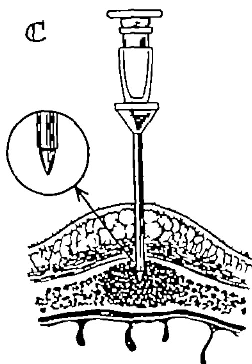
**C** Scalp and outer plate of the calvarium bored through by Turkel perforator

**D** The perforator is removed from the hollow cylinder and a needle trephine inserted to obtain a plug of tumor for pathologic study

The Turkel biopsy needle trephine lends itself well to obtaining bone biopsy for suspicious bone *tumors, especially of the calvarium*



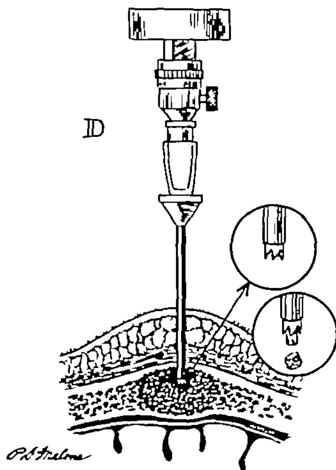




Plate 247

The diagnostic spinal puncture should be made with the patient in the horizontal position lying on either the right or left side with the lower spine flexed as much as possible. The skin is anesthetized with procaine immediately over the site through which the spinal needle is to be introduced. An 18 or 20 gauge spinal needle is inserted through the skin the point should engage the interspinous ligament at either the third or fourth lumbar space. By gentle advancement the needle is continued on its course through the ligament.

A The needle has engaged the interspinous ligament between the third and fourth spinous processes.

B The needle is advanced to the approximate depth of the ligamentum flavum.

C The stylet is removed a droplet of procaine is inserted into the hub of the needle.

D The needle is advanced with each thumb placed on the hub as demonstrated in A. As the epidural space is entered, the droplet of procaine can be seen receding into the hub of the needle. As the fluid recedes the spinal manometer is attached to the needle.

E As the needle with a manometer attached is advanced, the fluid will be seen to rise in the manometer as soon as the subarachnoid space is entered. This is usually 2 to 3 mm. deeper than in C, depending on the thickness of the fatty tissue in the epidural space.

In this manner an accurate pressure reading can be obtained without the loss of spinal fluid At this time the patient is asked to strain or pressure is made on the abdomen If the fluid in the manometer rises rapidly the needle is satisfactorily placed.

If the spinal puncture is performed in the presence of an intraspinal lesion, jugular compression is then instituted. On the other hand, if the spinal puncture is performed to determine the intraspinal pressure or the chemistry of the fluid, readings are made and the desired amount of fluid is allowed to escape for examination *In the detection of a partial spinal block it is important to repeat the jugular compression after the spinal fluid has been removed* At times a complete or partial block may develop after the removal of the spinal fluid.

F Sketch demonstrating the possibility of aspirating a nerve root against the needle.

In the removal of Pantopaque or spinal fluid by aspiration, turning the needle or syringe at the time suction is instituted should be avoided to prevent damage to a nerve root. During the removal of Pantopaque a minimal amount of exertion should be used on the piston of the syringe.

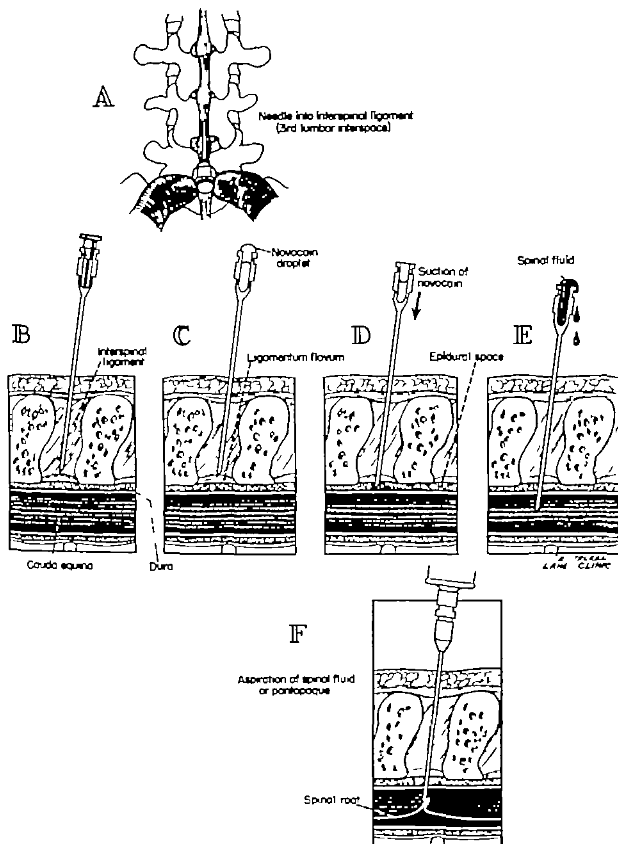

A
Needle into interspinal ligament
(3rd lumbar interspace)
B
C
D
E
Interspinal ligament
Novocain droplet
Suction of novocain
Spinal fluid
Ligamentum flavum
Epidural space
Cauda equina
Dura
F
Aspiration of spinal fluid or pantopaque
Spinal root

Plate 248

# INDEX

## A



## B

## C



## D



## E

# F



# G



# H



# I

# L



# M



# N



# O

L



M



N



O

## L



## M



## N



## O

# T



# U



# V



# W